AIR FORCE

QUALIFICATION TRAINING PACKAGE (AFQTP)

for

ELECTRICAL SYSTEMS

(3E0X1)

MODULE 16

OVERHEAD DISTRIBUTION SYSTEMS

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MODULE 16

OVERHEAD DISTRIBUTION SYSTEMS

Career Field Education and Training Plan (CFETP) references from 1 Apr 97 version.

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INTRODUCTION

Before starting this AFQTP, refer to and read the "Trainee/Trainer Guide" located on the AFCESA Web site **http://www.afcesa.af.mil/** . This guide will be found at each AFS's AFQTP download page.

AFQTPs are mandatory and must be completed to fulfill task knowledge requirements on core and diamond tasks for upgrade training. ***It is important for the trainer and trainee to understand*** that an AFQTP ***does not*** replace hands-on training, nor will completion of an AFQTP meet the requirement for core task certification. AFQTPs will be used in conjunction with applicable technical references and hands-on training.

AFQTPs and Certification and Testing (CerTest) must be used as minimum upgrade requirements for Diamond tasks.

MANDATORY minimum upgrade requirements:

Core task:
AFQTP completion
Hands-on certification

Diamond task:
AFQTP completion
CerTest completion (80% minimum to pass)

Note: *Trainees will receive hands-on certification training when equipment becomes available either at home station or at a TDY location.*

Put this package to use. Subject matter experts under the direction and guidance of HQ AFCESA/CEOT revised this AFQTP. If you have any recommendations for improving this document, please contact the Electrical Career Field Manager at the address below.

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Notice. This AFQTP is *NOT* intended to replace the applicable technical references nor is it intended to replace hands-on training if equipment is available. It is to be used in conjunction with these for training purposes only.

CLIMB POLES

MODULE 16 **AFQTP UNIT 1**

USING GAFFS (16.1.1.)

Notice. This AFQTP is *NOT* intended to replace the applicable technical references nor is it intended to replace hands-on training if equipment is available. It is to be used in conjunction with these for training purposes only.

USING GAFFS

Task Training Guide

STS Reference Number/Title:	16.1.1. – Overhead distribution, climb poles using gaffs
Training References:	• Lineman's and Cablemans Handbook, CerTest Vol. 138 Climbing Wooden Poles
Prerequisites:	• Possess as a minimum a 3E031 AFSC
Equipment/Tools Required:	• Climbers, body belt, leather gloves, hard-hat, steel toed boots
Learning Objective:	• Given climbing equipment, ascend and descend wooden utility pole
Samples of Behavior:	• Following approved method, safely ascend and descend wooden utility pole using all required climbing equipment, without falling
Notes:	
• To successfully complete this element, follow the steps outlined in the applicable technical manual exactly with no exceptions. • Any safety violation is an automatic failure.	

USING GAFFS

Background: Pole climbing is necessary in constructing and maintaining overhead exterior electrical systems. The climbing part of overhead work isn't difficult or hazardous if you are careful and follow the fundamental procedures of climbing. Accidents resulting from climbing can be reduced if a few simple rules are applied. Although most cutouts are due to improper climbing techniques, a large number are due to improper care and maintenance of climbers. To become 100 percent efficient as a lineman, it's essential you learn to both climb and position yourself on the pole so you can work with ease and with efficiency. To learn these procedures refer to CerTest tape #138, "Climbing Wooden Poles" and AFQTP's 24.1.7. & 16.5.

To Perform the task, follow these steps:

Step 1: Inspect pole for

- Unsafe conditions before and during the climb (decayed or worn areas, knot, shell rot, splits, cracks, protruding bolts, and anything that will deflect the gaff).
- Make sound test by striking pole with a hammer from ground level to highest reachable point.
- Clear rocks and other objects from around the base of the pole.

Step 2: Inspect climbers and body belt for

- Loose and dull gaffs.
- Broken or loose leg or ankle strap loops.
- Excessively worn, cracked, or torn straps and pads.
- Broken or loose rivets and screws on sleeves and straps.
- Improper gaff lengths. (checked with proper manufacturer's gaff gauge)
- Cracks and cuts tending to tear the leather or affect belt strength.
- Leather loops holding D-rings that are worn or crushed.
- Torn or badly damaged hole for the buckle tongue.
- Safety strap for excessive wear.
- Proper sizing and fit.

NOTE:
Report any damaged items to supervisor for repair or replacement. Damaged straps should be reported immediately.

SAFETY:
ALWAYS GIVE YOUR CLIMBING GEAR A COMPLETE INSPECTION BEFORE CLIMBING. ENSURE THAT ALL GROUND PERSONNEL AND EQUIPMENT REMAIN AT LEAST 10' FROM THE POLE WHEN SOMEONE IS CLIMBING.

Step 3: Ascending the pole.

- Climb the back or high side when possible (The side of the pole leaning away from you).
- Keep arms and body relaxed, keeping the hips, shoulders, and knees a comfortable distance away from the pole.
- Climb with short steps, approximately 8 to 10 inches.
- Use hands and arms for balance only.
- Extend arms and hands and place them at shoulder level to prevent pulling yourself up with your arms (Let your legs do the work).
- Aim gaffs at the heart (center) of the pole, keeping toes pointed upward at a 30 degree angle.
- Body weight is transferred on each step to the lower foot.
- Lock the knee of the lower leg to ensure that if you slip, your body weight will drive the gaff on the locked leg back into the pole.
- Develop coordination between your hands and feet so that when your left foot raises the left arm raises and when the right leg raises the right arm raises also.
- Keep approximately eight inches between the knee and the pole.
- Always set your gaffs in firmly.

NOTE:
Never wear climbers when working on the ground, while traveling in a vehicle, when working on a ladder, or on a stepped pole.

SAFETY:
WHEN NECESSARY TO CLIMB ICE OR SLEET COVERED POLES, SPECIAL CARE MUST BE TAKEN TO SEAT THE GAFFS IN THE WOOD OF THE POLE.

Step 4: Descending the pole.

- Maintain proper climbing position and relax as your shoulders, hips, and knees remain a comfortable distance from the pole.
- Look where you are going to insure you don't step into a bad spot.
- Look down your body, between your feet (Not from side to side).
- Right arm and leg will move together and the left arm and leg will move together.
- Break gaffs out the pole by rotating the knee to the outside during decent, with a outward and lowering movement of the knee.
- Keep it aimed at the heart of the pole at ALL TIMES.
- Relax and straighten this leg by locking back the knee BEFORE lowering.
- With the straightened and relaxed leg, line up with the heart of the pole and the body weight has been shifted above the gaff, drop the gaff into the pole.
- Steps should be approximately twice as long descending than ascending a pole, but not excessively long.
- The last step to the ground should be 6 inches or less to prevent gaffing yourself.

NOTE:
DO NOT try to coast or slide when descending a pole LIKE a lumberjack.

Review Questions for Using Gaffs

Question	Answer
1. If a pole is leaning, which side should be climbed?	a. Climb the back or high side when possible. b. Climb the front or high side when possible. c. Climb the front or low side when possible. d. Climb the back or low side when possible.
2. When descending the pole, how should you look where you are going?	a. Side to side. b. Down your body, between your legs. c. Down the side you feel most comfortable with. d. Look straight ahead at the pole.
3. You should always inspect climbing gear prior to use.	a. True b. False
4. Aim gaffs at the heart (center) of the pole, keeping the toes pointed upward at a ____ degree angle.	a. 20 b. 30 c. 45 d. 90
5. When ascending the pole, you should climb with short steps, approximately ___ to ___ inches.	a. 4, 6 b. 6, 8 c. 8, 10 d. 10, 12
6. The last step to the ground should be how far from the ground?	a. 6 inches b. 12 inches c. 16 inches d. 2 feet
7. What should you inspect your climbers and body belt for?	a. Loose, dull gaffs b. Broken or loose leg or ankle strap loops c. Broken or loose rivets and screws on sleeves and straps. d. All of the above.

USING GAFFS

Performance Checklist		
Step	**Yes**	**No**
1. Did trainee properly inspect climbing equipment?		
2. Did trainee inspect pole for climbing?		
3. Did trainee use proper climbing technique to ascend pole?		
4. Did trainee use proper climbing technique to descend pole?		

FEEDBACK: Trainer should provide both positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the mind of both the trainee and trainer.

CLIMB POLES

MODULE 16 **AFQTP UNIT 1**

WORKING ON POLE COMPONENTS (16.1.2.)

Notice. This AFQTP is *NOT* intended to replace the applicable technical references nor is it intended to replace hands-on training if equipment is available. It is to be used in conjunction with these for training purposes only.

WORKING ON POLE COMPONENTS

Task Training Guide

STS Reference Number/Title:	16.1.2. - Overhead distribution systems, climb poles while working on pole components
Training References:	• Lineman's and Cablemans Handbook Section 44 , CerTest Vol. 138 Climbing Wooden Poles, (not a good reference)
Prerequisites:	• Possess as a minimum a 3E031 AFSC
Equipment/Tools Required:	• Climbers, body belt, leather gloves, hard-hat safety toed boots
Learning Objective:	• Given climbing equipment, obtain a correct work position on a wooden utility pole using
Samples of Behavior:	• Following approved methods, safely belt-in and unbelt using safety strap, circle, hitch-hike up and down, and obtain a correct work position on a wooden utility pole using all required climbing equipment, without falling. • Climb with confidence
Notes:	
• To successfully complete this element, follow these steps . (none exist at this time unless you refence AFR 91-12.) • Any safety violation is an automatic failure.	

WORKING ON POLE COMPONENTS

Background: Working on pole components is an important skill all linemen need to know, but the reason you are going up the pole is to complete a job. You are going to need both hands free to perform any work on the pole and you can't have them free if you are holding on. Belting-in using your safety strap allows you to use your hands for working and not holding the pole. All work on a pole can't be done from one place. You must move on the pole to be in a safe and comfortable position to do the job. Circling on a pole is necessary for moving into the best position for work. While working on a pole it may become necessary to move up or down for a short distance. Since it would be inconvenient to belt-in and unbelt every time, you will need to know how to hitch-hike. By the use of hitch-hiking you can move up and down without unbelting. While pole climbing is a critical skill lineman must be able to master, it is only transportation to where the work is to be done. After climbing the pole and properly belting-in, the lineman must be able to circle, hitch-hike and finally get into a good work position so that the job can be completed. A good work position allows you to work on the pole components in the safest and most comfortable way.

To perform the task, follow these steps:

Step 1: Belting-in with safety strap (Right handed lineman).

- Lower and lock left leg.
- The right leg will be 6" above the left leg in a comfortable position.
- Keep the knees and hips away from the pole and unstrap the single end of the safety strap with the left hand while holding onto the pole with the right hand.
- Pass the single end around the pole to the right hand.
- Grasp the pole with the right hand and snap the keeper into the D-ring with the left.
- Both keeper snaps will face outward when strapped in around the pole correctly.
- The strap should lie flat against the pole.
- Always look to be sure the snaps are secured and properly engaged.
- Now the body weight can be placed on the safety strap.

NOTE:
Always visually check to make sure the snap keepers clip in to the D-ring.

Step 2: Unbelting with a safety strap (right handed lineman).

- Lower and lock left leg
- The right leg will be 6" above the left leg in a comfortable position.
- Grasp the pole with the left hand and pull up on the left leg being careful to keep the correct angle on the gaff.
- Carefully, with the right hand, unsnap the hook from the right D-ring.
- Pass the safety strap to the left hand.
- Grasp the pole with the right hand.
- Use the left hand to snap the safety strap into the left D-ring.
- Make sure that the proper knee angle is maintained while belting-in and unbelting

Step 3: Circling.

- To circle left, position the left foot six inches lower than the right with the left knee in the "locked" position.
- Position your right gaff close to the left foot and about six inches higher than the left foot.
- Shorten the safety strap on the left side by rotating your hips slightly in the clockwise direction.
- As you step up on the right foot, (locking the right knee) the left gaff will come out of the pole and your body will swing to the left.
- Keep your left knee locked and your left gaff aimed at the heart of the pole AT ALL TIMES.
- At this point both knees should be locked.
- Swing your left foot three to four inches to the left, unlock your right knee and drop onto your left gaff.
- The steps around the pole should not be too far apart (no more than three to four inches horizontally), as it could cause your right gaff to come out of the pole.
- Continue the process until you have reached your desired position.
- Circling to the right is the opposite procedure.
- Just have the right leg low and locked, bring the left foot close to the right and about six inches higher.
- Shorten your safety strap, step up on the left foot and swing to the right keeping the gaff aimed at the pole and dropping down onto a LOCKED right leg.

Step 4: Hitch-hiking up.

- Climb to a comfortable position at any part of the pole and strap-in.
- Flip belt up the pole (this is done by slightly moving your hips toward the pole and flipping the strap with your hands).
- With belt at a slight angle take one or two small steps up and lock our leg back when stepping up.
- Continue this process until you've reached the desired position.

Step 5: Hitch-hiking down.

- Flip strap down (this is done by slightly moving your hips toward the pole and flipping the strap with your hands).
- Take one small step down.
- Use your weight to drive your gaff into the pole.
- Continue this process until you get close to the ground.
- Unbelt before stepping off of the pole.

NOTE:
Always make sure you don't gaff into knots, cracks, or hardware items when climbing.

Step 6: Work Positions.

- Lower and lock right leg.
- Lengthen your safety strap slightly to the right.
- Twist slightly in your body belt to face your work.
- Upper body should be parallel with the crossarm.
- When working on crossarm components, the arm should be approximately chest high.
- All weight should be on the right foot.
- The left leg is not used, so position it any way you feel comfortable.
- .(Some do not have metal tags)
- Rotate in your body belt until both hips are parallel to the crossarm.
- Work position to the left is the same procedure.
- Just have the left leg low and locked, lengthen the safety strap to the left and twist to face your work.
- Upper body remains parallel with the crossarm and all weight should be on the left foot.
- The right leg is not used, so position it any way you feel comfortable and . rotate in your body belt until both hips are parallel to the crossarm.

NOTE:
Having your belt too high will cause you to work too hard to bend and flex. This will cause your back to tire quickly. Having the belt too tight will keep you from twisting properly and can also reduce circulation to your legs making them numb.

SAFETY:
ALWAYS REMEMBER THAT ALL YOUR WEIGHT IS ON ONE LEG, THAT LEG MUST REMAIN LOCKED. IT WILL BE EXTREMELY HARD TO GAFF BACK INTO THE POLE IF THE LOWER LEG ISN'T LOCKED.

Review Questions
for
Working On Pole Components

Question	Answer
1. In what direction should the keepers face when belting-in?	a. Both inward b. Both outward c. Right handed climbers face inward d. Left handed climbers face inward
2. How can the climber tell if the keeper has snapped into the D-ring?	a. Looking b. Listening c. Feeling d. All of the above
3. What is the reason for circling?	a. Obtaining best position for work b. Allow you to have free access of your hands c. To move up and down on the pole. d. To work on pole components in the safest and most comfortable way.
4. If you are circling to the left, which leg is low and locked?	a. Left leg b. Right leg c. Both legs d. Neither leg
5. How much distance should be gained around the pole with each swing?	a. 3 to 4 inches vertically b. 3 to 4 inches horizontally c. 4 to 6 inches vertically d. 4 t 6 inches horizontally
6. What is the purpose of hitch-hiking?	a. Obtaining best position for work b. Allow you to have free access of your hands c. To move up and down on the pole. d. To work on pole components in the safest and most comfortable way.
7. Body weight is used to drive the gaff into the pole when hitch-hiking.	a. True b. False
8. At what level should the crossarm be when working on crossarm components.	a. Above the head. b. Eye level c. Chest level. d. Waist level`
9. It is important to keep your low leg locked in work positions, because all your weight is on that one leg.	a. True b. False

WORKING ON POLE COMPONENTS

Performance Checklist		
Step	**Yes**	**No**
1. While belting-in did trainee properly pass strap around the pole?		
2. While belting-in did trainee properly strap keeper faces outward?		
3. While circling left did trainee position left foot six inches lower than right foot?		
4. While circling did trainee drive the gaff in the pole using body weight?		
5. While hitch-hiking up did trainee lock their leg back after each step?		
6. While hitch-hiking down did trainee take ONE small step down?		
7. While work positioning to the right did trainee lower and lock the right leg?		
8. While work positioning to the right did trainee twist in body belt so that their hips are parallel to the crossarm?		

FEEDBACK: Trainer should provide both positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the mind of both the trainee and trainer.

CLIMB POLES

MODULE 16 **AFQTP UNIT 1**

TRAVERSING OBSTACLES (16.1.3.)

Notice. This AFQTP is *NOT* intended to replace the applicable technical references nor is it intended to replace hands-on training if equipment is available. It is to be used in conjunction with these for training purposes only.

TRAVERSING OBSTACLES

Task Training Guide

STS Reference Number/Title:	16.1.3. – Overhead distribution systems, climb poles while traversing obstacles
Training References:	• Lineman's and Cablemans Handbook Section 44 , CerTest Vol. 138 Climbing Wooden Poles
Prerequisites:	• Possess as a minimum a 3E031 AFSC
Equipment/Tools Required:	• Climbers, body belt, leather gloves, hard-hat, steel toed boots
Learning Objective:	• Given climbing equipment, traverse obstacles to obtain a work position on a wooden utility pole
Samples of Behavior:	• Following approved methods, safely traverse a single crossarm, double crossarm or clevis to obtain a work position on a wooden utility pole using all required climbing equipment, without falling • Perform task with confidence
Notes:	
• To successfully complete this element, follow the steps outlined in this training package. • Any safety violation is an automatic failure.	

TRAVERSING OBSTACLES

Background: Not all poles are going to be free of obstacles. Knowing the proper way to climb over obstructions is essential to doing the job. Climbing over or around single, double crossarms and clevis are some of the obstructions that you may have to traverse to get to work locations. Even with advanced planning, climbing over or around some obstructions may still be unavoidable. All your climbing skill will be put to the test when you encounter an obstacle.

To perform the task, follow these steps:

Step 1: Inspect pole equipment.

- Locate any crossarms, transformers, or other objects you may need to climb over or around.
- Check the pole by sounding it with a hammer.
- Inspect your climbing equipment.

Step 2: Plan route.

- Plan climbing route to avoid as many obstructions as possible.
- Climbing over and around some obstructions may still be unavoidable.

Step 3: Ascending past single crossarm.

- Climb the side opposite the crossarm and avoid climbing over the crossarm.
- The only obstacle now is the head of the bolt holding the crossarm.
- Your body and climbers will never get near the crossarm however, your hands and arms are near the crossarm because they are extended around the back side of the pole and this can be very dangerous.

SAFETY:
TAKE PARTICULAR CARE NOT TO REACH BETWEEN THE CROSSARM BRACES AND THE POLE--IF YOU SLIP, YOUR HAND COULD GET CAUGHT WITH SERIOUS CONSEQUENCES.

NOTE:
If it is not possible to climb the backside of a pole, use the same approach on a single arm as you would for a double arm.

Step 4: Descending single crossarm.

- Climbing down is simply the reverse procedure.
- Be careful your gaff penetrates wood.
- Avoid metal objects
- As you descend, look down between your legs.

Step 5: Ascending past double crossarm.

- Climb until your shoulders or at the same level as the lag screw.
- Grasp the crossarm with one hand, while holding onto the pole with the other, and check for sturdiness.
- If it feels sturdy, use the arm for support and climb on up.

- It is acceptable to climb onto the crossarm, but put your weight on it gradually to make sure it can support weight.

SAFETY:
BE CAREFUL NOT TO GAFF THE METAL BRACES AND BE CAREFUL YOUR FEET DON'T SLIP ON THE ARM.

NOTE:
On a pole with a faulty double arm, you need to modify the procedure so you do not use the crossarm for support.

- Climb high enough to grab the pole above the crossarm and continue climbing until your gaffs are close to the braces.
- Carefully set one climber between the braces
- Step up onto that leg and then gaff above the crossarm with the other leg.

NOTE:
For most of us this is a fairly long step so be sure your gaffs are set firmly and you have a good hold on the pole. This is one of the few times you use your arms to pull yourself up.

Step 6: Descending double crossarm.

- Climbing down is simply the reverse procedure.
- Be careful your gaff penetrates wood.
- Avoid metal objects.
- As you descend, look down between your legs.

Step 7: Ascending past clevis(es).

- Climb the pole until eye level with the clevis.
- Place your hands above the clevis and while maintaining hand/foot coordination climb until a foot is just below the clevis.
- Put one foot above the clevis.
- Once above the clevis, climb on as usual.

SAFETY:
BE CAREFUL NOT TO GAFF INTO ANYTHING METALLIC. USE CARE NOT TO STEP ON THE CONDUCTOR AS YOU CLIMB OVER IT, OUR METAL CLIMBER WILL SLIDE ON THE METAL CONDUCTOR AND CREATE A DANGEROUS SITUATION.

Step 8: Descending Clevis(es).

- Climbing down is simply the reverse procedure.
- Be careful your gaff penetrates wood.
- Avoid metal objects.
- As you descend, look down between your legs.

Review Questions
for
Traversing Obstacles

Question	Answer
1. Prior to traversing obstacles, what must you do?	a. Inspect pole equipment b. Inspect climbing equipment c. Plan route d. All of the above
2. Conductor can be used as a climbing support.	a. True b. False
3. When traversing a single crossarm what side of the pole do you climb?	a. Crossarm side b. Opposite of crossarm side c. Directly under crossarm d. None of the above
4. When traversing a double crossarm you must climb high enough to_____.	a. Slip your hand between the crossarm braces b. Pull up on the crossarm braces c. Touch the bottom of the crossarm d. Grab the pole above the crossarm.
5. When traversing a clevis, climb the pole until the clevis is _____ level with the lineman.	a. Eye b. Shoulder c. Chest d. Waist
6. When descending an obstruction, how should you look where you are going?	a. Down your body, between your legs. b. Side to Side c. Look straight ahead d. Do whatever feels most comfortable for you.

TRAVERSING OBSTACLES

Performance Checklist		
Step	**Yes**	**No**
1. While traversing a single crossarm did trainee circle to the opposite side of the crossarm?		
2. While traversing a double crossarm did trainee check for sturdiness before applying any weight?		
3. While traversing a clevis did trainee maintain a hand / foot coordinated climb?		
4. While descending from obstruction did trainee avoid gaffing into metal objects?		

FEEDBACK: Trainer should provide both positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the mind of both the trainee and trainer.

HANDLE POLES

MODULE 16 **AFQTP UNIT 3**

SET UTILITY POLES (16.3.4.)

Notice. This AFQTP is *NOT* intended to replace the applicable technical references nor is it intended to replace hands-on training if equipment is available. It is to be used in conjunction with these for training purposes only.

SET UTILITY POLES

Task Training Guide

STS Reference Number/Title:	16.3.4. – Overhead distribution systems, handle poles while setting utility poles
Training References:	• Video 16.3.4. V (Setting and Removing Poles) • CDC 3E051B Vol. 1
Prerequisites:	• Possess as a minimum a 3E031 AFSC.
Equipment/Tools Required:	• Pole • Line truck • Digging tools • General tool kit
Learning Objective:	• Given equipment, set utility poles
Samples of Behavior:	• Set utility pole using approved vehicles • • Know safety requirements associated with setting utility poles
Notes:	
• Any safety violation is an automatic failure.	

SET UTILITY POLES

Background: Poles are usually set with the line maintenance truck.

Setting poles using line truck.

- The length of the pole hole in normal soil is 10% of the pole length plus 2 feet. Ex. 10 % of 40 feet is 4 feet, and 4 feet plus 2 feet equals 6 feet.
- The diameter of the pole, plus twice the width of the tamper determine the diameter of the pole hole. Ex. A pole 10 inches in diameter plus twice the width of a 3-inch tamper would need a pole hole of 16 inches.
- The auger should be placed in a vertical position during the digging process.
- When the line truck can not reach the location of the pole hole, the spoon and spade method will be used.
- The balance point of the pole is located lower than the halfway point of the pole.
- Whenever a pole is framed on the ground the balance point must be readjusted.
- The cant hook is used to rotate the pole left and right to allow for proper alignment.
- Pole guards are used to insulate poles from energized sources.

SAFETY:
WHENEVER RAISING A POLE IN ENERGIZED LINES, REMEMBER THAT CONTAMINANTS AND PRESERVATIVES COULD CAUSE THE POLE TO BECOME ENERGIZED, IF IT CONTACTS AN ENERGIZED SOURCE. PROPER PROTECTIVE EQUIPMENT, SUCH AS LINE GUARDS,
POLE GUARDS, RUBBER GLOVES AND SLEEVES SHOULD BE USED TO PREVENT CONTACT WITH ANY ENERGIZED CONDUCTORS

To perform these tasks, view video **16.3.4.V (Setting and Removing Poles),** then follow the steps for setting a pole using a line truck**:**

VIDEO NOTE:
During the video, the spokesperson will direct you to review the segment of the video covered and to answer the question at the end of the unit. Disregard those statements and view the video in its entirety. Special attention should be focused on the following sections: 1. Digging the Hole; 2. Pole Setting Using a Derrick; . After the video has been viewed return to this AFQTP, review the steps listed below and answer the review questions.

Step 1:Dig hole.

- Determine the size, depth and location of hole to be dug
- Position digger derrick so auger will reach area to be dug, stabilize and level truck-using outriggers.
- Swing boom into proper position, lower auger into position to begin digging.
- A ground man will use standard hand signals to guide auger throughout digging operations.
- While digging with the auger you must apply a downward pressure with the boom to help force the auger into the ground.
- Once the auger is full of dirt you must raise the auger and the ground man will help remove the dirt (repeat this process until depth of hole is reached).
- Once digging is completed, clean and stow auger.

Step 2: Set pole.

- Reposition digger derrick to install pole and position pole next to hole
- Find balance point and rig pole for lifting.
- Open pole grabbers and adjust angle to receive pole.
- Raise the pole into position using a combination of winch, boom and rotation.
- When the pole is fully vertical, close pole grabber's loosely around pole to maintain control of the pole.
- Slowly let out the winch line to lower pole into the hole. The ground man will help guide the butt to the bottom of the hole. (ensure the butt is centered in the hole once it rest on the bottom)

Step 3: Align and plumb pole.

- Use a cant hook to align pole so the crossarm will be perpendicular to the feeder lines.
- To plumb the pole the ground man will check from at least two positions 90 degrees apart using a plumb bob.
- The ground man will use hand signals to indicate which way the pole should move.

Step 4: Back filling and tamping.

- Backfill layers of dirt a couple of inches deep, then tamp and firmly compress it. Repeat this process until entire hole is back-filled.
- Pile remaining dirt around base of pole, creating a rain shed for drainage.

Step 5: Release pole.

- Open pole grabbers and angle back completely.
- Release tension on winch line, ground man will then climb pole and disconnect hook and lower sling.
- Stow the auger, cradle boom and raise outriggers.

Review Questions
for
Set Utility Poles

Question	Answer
1. A pole 50 feet in length should be set ____ feet in the ground in normal soil.	a. 4 b. 5 c. 6 d. 7
2. The diameter of a hole for a pole 15 inches in diameter, being tamped with a 2-inch wide tamper should be at least _____ inches in diameter.	a. 16 b. 17 c. 19 d. 21
3. In what position should an auger be placed during the digging process?	a. 45 degree angle b. 90 degree angle c. Vertical d. Horizontal
4. The balance point of the pole is located higher than the halfway point of the pole.	a. True b. False
5. What is used to rotate the pole left and right to allow for proper alignment?	a. Cant hook b. Pike c. Jinny d. Winch line

SET UTILITY POLES

Performance Checklist		
Step	**Yes**	**No**
1. Can trainee properly position and set up the digger derick?		
2. Can trainee determine the depth a hole needs to be, given the pole length and soil type?		
3. Did the trainee properly dig the hole?		
4. Did trainee ensure that before lifting a pole that it was slightly butt heavy?		
5. Did trainee successfully raise then lower pole into the hole?		
6. Did the trainee properly align and plumb the pole?		
7. Did the trainee backfill and tamp the pole in layers?		
7. Did the trainee release the pole and safely stow the boom?		

FEEDBACK: Trainer should provide both positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the mind of both the trainee and trainer.

INSTALL:

MODULE 16 **AFQTP UNIT 4**

OVERHEAD LINE CONDUCTORS (16.4.2.)

Notice. This AFQTP is *NOT* intended to replace the applicable technical references nor is it intended to replace hands-on training. It is to be used in conjunction with these for training purposes only.

OVERHEAD LINE CONDUCTORS

Task Training Guide

STS Reference Number/Title:	16.4.2. – Overhead distribution systems, install overhead line conductors
Training References:	• Video 16.4.2.Video (Overhead Line Conductors) • CDC 3E0X1B Vol. 1
Prerequisites:	• Possess as a minimum a 3E031 AFSC.
Equipment/Tools Required:	• Conductor • Puller • Tensioner • Pilot lines • Dynamometer • Basket grip • Stringing dollies
Learning Objective:	• Given equipment, install overhead line conductors
Samples of Behavior:	• Following approved methods, install overhead line conductors • Know safety requirements associated with installing overhead line conductors
Notes:	
• Any safety violation is an automatic failure.	

OVERHEAD LINE CONDUCTORS

Background: After the pole line is installed, you are now ready to install the conductors. There are many things you have to take into consideration when stringing conductors. Among them are the location of crossarms and the spacing of the conductors on them. After the conductors are raised to the crossarms or supports, you must then sag them into proper position and properly secure them.

To perform these tasks, view video **16.4.2.V (Distribution Line Installation and Removal):**

VIDEO NOTE:
During the video the spokesperson will direct you to review the segment of the video covered and to answer the questions at the end of the unit. Disregard those statements and view the video in its entirety. After the video has been viewed, return to this AFQTP, review the steps listed below and answer the review questions.

Step 1: Plan Job.

- Any overhead work begins with a tailgate session in which the job is explained to each worker.
- The sequence of events for installing overhead lines is: installing the new conductor; energizing and the phasing in of the new line; and the removal of old conductors if necessary.
- The size of conductor being installed will determine the type of puller you will use to install the conductors.
- In order to prevent sagging of conductor between spans, a tensioner is used to apply resistance on the guideline or conductor being pulled through.
- Pilot lines are small nylon ropes used for the pulling of the conductors during the first steps of the installation.

NOTE:
Pilot lines are normally used on large conductors or long conductor runs. Normally, a hand line is attached to a pole and the conductor is hoisted up to the crossarm and tied into place.

SAFETY:
WHENEVER THE POTENTIAL FOR ACCIDENTAL CONTACT OF OVERHEAD CONDUCTORS AND ENERGIZED EQUIPMENT EXISTS, THE EQUIPMENT IN QUESTION SHOULD BE COVERED WITH RUBBER PROTECTIVE EQUIPMENT.

- Preventing the contact of personnel and equipment, with energized circuits can be accomplished by insulating and isolating.
- When installing conductors on or around poles with energized lines, always ground the equipment you are using to the conductors being installed and bond them to the system neutral.

SAFETY:
BEFORE ENERGIZING NEW LINES ENSURE ALL GROUNDS ARE REMOVED.

Step 2: Prepare crossarms.

- As good practice, always mount stringing dollies as close to insulators as possible, this will ease in the mounting of the conductors.
- If installing new conductor on a pole with existing conductor, a buckarm can be used to raise original conductor out of the way.
- The line truck is grounded by connecting a ground clamp to a separate ground and the other end to the truck itself.

Step 3: Install overhead conductor.

- The proper sequence of events for installing a new overhead conductor is: Setting up the pulling mechanism; stringing the conductor; dead-ending and sagging the line; and phasing in the new circuit.
- If a puller is used, a bull rope will be mounted on it, while the cable is positioned on the tensioner.

NOTE:
Remember to ground both the puller and the tensioner.

- When using a tensioner during the installation process, slow down the speed of the tensioner when the basketgrip reaches the stringing dolly of a crossarm.
- Final sag is performed after a predetermined period of time has passed.
- Dynamometers are used to measure the conductors tension in foot-pounds.

Step 4: Energize and phase-in overhead conductors.

- Phasing tools are used to determine jumper connections of drawing to ensure that they are accurate.

SAFETY:
NEVER ASSUME THAT DRAWINGS OR SCHEMATICS ARE CORRECT.
ALWAYS DOUBLE CHECK USING A HIGH VOLTAGE PHASING SET YOUR LIFE DEPENDS ON IT.

- The proper sequences of events for phasing in new overhead conductors are: testing the phasing set used by checking across different phases (must have voltage reading) then across same phase (no voltage reading).Then phasing the conductors in.
- The indication for phasing two conductors together is a zero or a near zero reading on the phasing set .

SAFETY:
ALWAYS USE RUBBER PROTECTIVE EQUIPMENT WHEN WORKING ON ENERGIZED OVERHEAD LINES.

Review Questions
for
Overhead Line Conductors

Question	Answer
1. Any overhead work should begin with a _____ session in which the job is explained to each worker.	a. Job advisory b. Staff c. Tailgate d. Equipment status
2. What determines the pulling equipment used during an overhead conductor installation?	a. The length of the spans b. The type of conductor c. The size of conductor d. The length of poles
3. Pilot lines or normally only used on large conductors or long conductor runs.	a. True b. False
4. Whenever the potential for contact between overhead conductors and energized equipment exists, what must be accomplished?	a. Deenergized the circuit b. Be very careful c. Wear rubber protective equipment d. Cover equipment with rubber blankets.
5. When installing conductors on or around poles with energized lines, always ground the equipment you are using to the conductors being installed and bond them _____.	a. Together b. To the pole ground c. To the system neutral d. To the energized lines
6. The line truck is grounded by connecting a ground clamp to a separate ground and the other end to the truck itself.	a. True b. False
7. The first step before phasing in an overhead line is _____.	a. Ensuring that conductors are the same voltage b. Testing the phasing set c. Read for zero indication d. All of the above

OVERHEAD LINE CONDUCTERS

Performance Checklist		
Step	**Yes**	**No**
1. Can trainee explain the steps to planning the installation of overhead conductors.		
2. Did trainee use stringing dollies while installing overhead conductors?		
3. Does Trainee know the sequence of events for phasing in overhead conductors?		
4. Did trainee properly sag conductors?		

FEEDBACK: Trainer should provide both positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the mind of both the trainee and trainer.

INSTALL:

MODULE 16 **AFQTP UNIT 4**

CONDUCTOR SUPPORT DEVICES (16.4.4.1.)

Notice. This AFQTP is *NOT* intended to replace the applicable technical references nor is it intended to replace hands-on training. It is to be used in conjunction with these for training purposes only.

CONDUCTOR SUPPORT DEVICES

Task Training Guide

STS Reference Number/Title:	16.4.4.1. – Overhead distribution systems, install conductor support devices
Training References:	• CDC 3E051B, VOL3; Lineman's and Cableman's Handbook, •
Prerequisites:	• Possess as a minimum a 3E031 AFSC
Equipment/Tools Required:	• Personal protective equipment, basic electrician hand tools
Learning Objective:	• Given equipment, install conductor support devices
Samples of Behavior:	• Following approved methods, install conductor support devices • Know safety requirements associated with installing conductor support devices
Notes:	
• Any safety violation is an automatic failure.	

CONDUCTOR SUPPORT DEVICES

Background: Several years ago, wooden crossarms were used exclusively to support distribution lines. Modern technology has brought about new types of supports, quickly replacing the wooden crossarms. This type of new construction is called armless. The armless style of construction is easier to install and maintain. Many poles are still equipped with crossarms and these will need to be maintained.

NOTE:
Conductor support devices are used to support the conductor off of the ground. The support devices separate the conductors physically and electrically. The conductors must be spaced according to the voltage of the conductor. The support device supports insulators which insulate the conductors from ground and they are positioned far enough apart to prevent arc over.

To perform this task, follow these steps:

Step 1: Install wooden crossarm.

NOTE:
While the linemen are getting their gear on, the groundman should uncoil the handline and zigzag the hand line out on the ground. The groundman then hooks the handline to the lineman's belt and the lineman climbs up to a work position.

- The lineman should be just below the throughbolt hole (12 inches from top of pole) which was drilled during pole framing.
- The groundman should prepare the crossarm while the lineman climbs.
- Once belted in, the lineman should attach the handline at the top of the pole.
- The hook on the handline should face down, the pulley should be on the side of the pole where the arm is to be lifted.
- Once installed, the lineman should have the groundman test the handline by pulling down on it to make sure it is secure and won't slip while lifting the crossarm.
- The lineman then installs the throughbolt from the opposite side of the pole that the crossarm is placed.
- Make sure the throughbolt has a washer on it.
- Once the throughbolt is in, the lineman should place their safety strap so that it is covering the head of the throughbolt.
- This prevents the bolt from being pushed out as the crossarm is being installed.
- The groundman places a clove hitch on the end of the crossarm that doesn’t have a pin.
- A half hitch is then placed on the end of the crossarm that will get raised first.
- The braces should face into the pole.
- The crossarm should be laid on the ground like it will be installed so it can be raised properly.

- The lineman should have their leg lowered and locked on the same side as the crossarm is to be raised.
- The groundman must be careful not to raise the crossarm into the lineman's feet.
- After the crossarm is raised up to the lineman, place the pin in the crossarm on the safety strap so that the half hitch can be untied.
- When the lineman is ready the groundman raises the crossarm higher as the lineman pivots the arm over to rest it on the safety strap near the body.
- The crossarm is now placed on the throughbolt and secured with a nut and washer .
- The lineman should then circle around the pole to the clove hitch and remove it.
- Getting into a proper work position and being high enough makes it easy to remove the knot.
- After that is accomplished, the lineman circles to the center and levels the crossarm with a bulb level or has the groundman sight the crossarm to ensure it's level from the ground.
- Once level, the lineman hitch-hikes down into a work position and hammers in the lag screw to secure the braces.

Step 2: Epoxy Arms.

- The vertical arms are installed to the sides of the pole with the first hole 9" from the top.
- The distance down to the next hole is dependent on the system voltage spacing required.
- Drill the holes from the side that the arm is to be installed.
- The handline is installed to the side of the lineman's position and as high as possible on the pole.
- The groundman then sends the arm, with the insulator installed, up the pole, using either a clove hitch or lineman's hitch.
- The lineman then installs the arm on the throughbolt and secures it.
- Next, vertically align the arm to the pole and lag screw it in.
- The lag screw should have a washer behind it to prevent hammering the lag into the soft aluminum construction of the arm.
- Complete the job by installing the rest of the arms in the same way until all the arms are installed.

Step 3: Pin Insulators.

> **NOTE:**
> There are several different insulators and the way they are installed depends on the type of insulator.

- The pin insulator is screwed to the pin on the crossarm.
- To align the groove on the insulator with the conductor, it sometimes requires loosening the pin's nut andwasher and turning the pin to align and then re-tightening the nut andwasher.
- Sometimes the insulators are installed on the crossarm prior to it being raised.

Step 4: Suspension Insulators.

- Suspension insulators are installed on an eyebolt or eyenut with a clevis pin and cotter key.
- The suspension insulator is installed on a doublearm or buckarm where the conductor terminates.
- Suspension insulator can be daisy chained to increase their insulation value.

Step 5: Spool Insulators.

- The spool insulator is installed in a clevis which is bolted to the pole.
- A pin is placed through the spool insulator and clevis.
- A cotter key is then placed on the pin.

SAFETY:

ENSURE THE AREA AROUND THE POLE IS CLEAR OF HARDWARE. ALWAYS MAKE SURE THAT TOOLS AND EQUIPMENT ARE SECURELY FASTENED TO HANDLINE BEFORE RAISING OR LOWERING. NEVER STAND UNDER SUSPENDED EQUIPMENT. WEAR EYE PROTECTION WHEN DRIVING LAG SCREWS.

Review Questions
for
Conductor Support Devices

Question	Answer
1. Conductor support devices are used to support the conductor off the ground.	a. True b. False
2. Installation procedures are the same on every job.	a. True b. False
3. Before raising the crossarm up the pole, the pins, insulators, braces and bolts should be installed by the _____.	a. Supervisor b. Crew leader c. Groundman d. Lineman
4. The crossarm braces have two different sized holes on the ends.	a. True b. False
5. The lineman should be just below the throughbolt hole, _____ inches from the top of the pole.	a. 12 b. 15 c. 20 d. 6
6. The vertical epoxy arms are installed to the sides of the pole with the first hole _____ inches from the top.	a. 12 b. 9 c. 18 d. 24
7. There are several different types of insulators and the way they are installed depends on the type of insulator.	a. True b. False
8. The suspension insulator is installed where the conductor terminates.	a. True b. False
9. The spool insulator is installed in a _____ which is bolted to the pole.	a. Frame b. Clevis c. Rack d. None of the above
10. Always ensure that tools and equipment are securely fastened to the handline before raising or lowering.	a. True b. False

CONDUCTOR SUPPORT DEVICES

Performance Checklist		
Step	**Yes**	**No**
1. Was crossarm sent up on the handline properly?		
2. Was crossarm secured and leveled?		
3. Were epoxy arms secured and leveled?		
4. Did trainee align grove of pin insulator?		
5. Did trainee install suspension insulator properly?		
6. Did trainee install spool insulator properly?		

FEEDBACK: Trainer should provide both positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the mind of both the trainee and trainer.

INSTALL:

MODULE 16 AFQTP UNIT 4

TRANSFORMERS (16.4.4.2.)

Notice. This AFQTP is *NOT* intended to replace the applicable technical references nor is it intended to replace hands-on training. It is to be used in conjunction with these for training purposes only.

TRANSFORMERS

Task Training Guide

STS Reference Number/Title:	16.4.4.2. – Overhead distribution systems, install transformers
Training References:	• CDC 3E051B, VOL3; Lineman's and Cableman's Handbook; •
Prerequisites:	• Possess as a minimum a 3E031 AFSC
Equipment/Tools Required:	• Personal protective equipment, electrician hand tools, hand line, transformer and lifting equipment
Learning Objective:	• Given equipment, install transformers
Samples of Behavior:	• Following approved methods, install transformers • Know safety requirements associated with installing transformers
Notes:	
• Any safety violation is an automatic failure.	

TRANSFORMERS

Background: Before installation, the transformer's data plate must be checked to make sure that the high voltage rating of the transformer matches the system voltage. The KVA and necessary secondary voltage rating of the transformer must match the customer's required load rating. Once the transformer is matched, the transformer is inspected to make sure it is in good operating order. This pre-inspection consists of tests and checks to ensure that the transformer windings are not opened, shorted, or grounded. Oil contained in the transformer must meet the specification required to provide adequate insulation and cooling of the transformer. The pre-installation test consists of an oil test, megger test, and overall inspection for condition of the transformer.

To perform this task, follow these steps:

Step 1: Install transformer directly to Pole (Manually).

NOTE:
Movement of transformers should be done with care to prevent damage. When mounting a transformer directly to the pole, equipment for the job must be gathered first.

- Gather equipment needed to manually raise a single-phase transformer (a handline, tagline, block and tackle, and transformer gin).
- The transformer gin is raised and installed directly over the spot the transformer will be installed.
- The block and tackle is raised next and placed on the loop of the transformer gin.
- A tagline is wrapped around the transformer and secured with a timber hitch.
- The transformer bracket is measured to determine the distance between the two throughbolt holes.
- The lineman then drills these holes in the proper position.
- Holes should be drilled on the side the transformer will be installed.
- Install the throughbolts so 2" of the bolt head is left exposed.
- No washers are required under the bolt heads.
- Make sure the throughbolts have enough threads exposed to tighten them and are not too short or long for installation.
- To raise the transformer, a sling/strap is hooked to the transformer lifting lugs and to the block and tackle**. (Never lift a transformer by its bushings)**
- Personnel then pull on the block and tackle slowly raising the transformer into position.
- One person works the tagline that is used to control and guide the transformer as it goes up the pole.
- One or two linemen on the pole help position the transformer over the throughbolts and give directions to the groundmen to raise and lower the transformer so it can be guided onto the bolts.
- The transformer is now held securely by groundmen as the linemen tighten the bolts.

Step 2: Install transformers on a Cluster Bracket (Manually).

- Gather equipment needed to manually raise a single-phase transformer (a handline, tagline, block and tackle, and transformer gin).
- Radial/wrap-around brackets are raised to the proper location and the bolts are tightened so the bracket binds against the pole.
- The bracket must be low enough to provide minimum clearance from primary lines.
- With the throughbolt mounted cluster bracket, two holes are drilled in the pole.
- The distance is determined by measuring the holes in the bracket.
- These holes should be drilled on the side the transformers will be installed.
- Install the throughbolts so 2" of the bolt head is left exposed.
- No washers are required under the bolt heads.
- Make sure the throughbolts have enough threads to tighten them and are not too short or long for the installation.
- Once the brackets are installed, the transformers are installed as discussed for direct mounted transformers.
- The transformer gin must be repositioned over each transformer location until all the transformers have been mounted in position.

Step 3: With Derrick Truck Winch.

- Using the line truck to raise the transformers eliminates the need for some equipment.
- With the line truck, a block and tackle and transformer gin is not needed.
- The line truck should be positioned next to the pole in such a position that the boom will reach and be able to maneuver around obstructions.
- The tagline is still used to control and guide the transformer as it is raised.
- The transformers are raised into position and secured by the linemen just as the manual lifting method.

NOTE:
Due to some obstructions, the line truck may need to be repositioned in order to reach all transformer locations.

SAFETY:
NEVER POSITION YOURSELF UNDER ANY SUSPENDED LOADS. THE USE OF GLOVES IS MANDATORY WHILE OPERATING A HANDLINE OR BLOCK AND TACKLE. TAGLINE IS USED TO GUIDE THE TRANSFORMER AROUND OBSTRUCTIONS AND STEADY IT. THIS PREVENTS DAMAGE TO THE TRANSFORMER AND THE LINE TRUCK. STAY CLOSE ENOUGH TO COMMUNICATE. LACK OF COMMUNICATION IS THE NUMBER ONE CAUSE OF INJURY AND DAMAGE TO EQUIPMENT.

Review Questions
for
Transformers

Question	Answer
1. Movement of transformers should be done with care to prevent damage.	a. True b. False
2. When raising a transformer manually, you can lift using the bushings.	a. True b. d. False
3. Cluster bracket transformer installation requires the same equipment as directly pole mounted.	a. True b. False
4. Due to some obstructions the line truck may need to be repositioned in order to reach all transformer locations.	a. True b. False
5. Never position yourself under any suspended loads.	a. True b. d. False

TRANSFORMERS

Performance Checklist		
Step	**Yes**	**No**
1. Did trainee mount transformer gin in proper location?		
2. Was a tagline used to guide transformer?		
3. Was the cluster bracket installed properly?		
4. Did the trainee position the line truck so the boom would reach and be able to move around obstacles?		
5. Were all bolts the proper length and all nuts tightened?		

FEEDBACK: Trainer should provide both positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the mind of both the trainee and trainer.

INSTALL:

MODULE 16 **AFQTP UNIT 4**

PROTECTIVE DEVICES (16.4.4.3.)

Notice. This AFQTP is *NOT* intended to replace the applicable technical references nor is it intended to replace hands-on training. It is to be used in conjunction with these for training purposes only.

PROTECTIVE DEVICES

Task Training Guide

STS Reference Number/Title:	16.4.4.3. – Overhead distribution systems, install protective devices
Training References:	• CDC 3E051B, VOL3; Lineman's and Cableman's Handbook; •
Prerequisites:	• Possess as a minimum a 3E031 AFSC
Equipment/Tools Required:	• Protective equipment, Basic electrician handtools, Lightning Arrester, Fused Cutout
Learning Objective:	• Given equipment, install protective devices
Samples of Behavior:	• Following approved methods, install protective devices • Know safety requirements associated with installing protective devices
Notes:	
• Any safety violation is an automatic failure.	

PROTECTIVE DEVICES

Background: Transformers must be protected from overvoltage and overcurrent conditions that can cause damage. Two devices that provide this protection are lightning arresters and fuse cutouts.

Overvoltage Protection. Lightning arresters are devices that provide overvoltage protection for equipment. They provide a low impedance path to ground for lightning and transient currents. Once the overvoltage condition is over, they restore the circuit to normal condition. When there is a high voltage condition (greater than normal line voltage), the lightning arrester provides a path to ground to drain off the excess voltage and prevent the further flow of current.

Overcurrent Protection. Fuse cutouts are inexpensive protective devices put in the circuit to open the circuits. This de-energizes equipment to prevent or limit damage from current overloads and short circuits. The fuse is a weak spot put into the circuit. It consists of a short piece of wire which melts at low temperatures. Excess current heats up the short wire which melts (blowing the fuse), opening the circuit before excess current can damage equipment. Fuses are classified as either low or high voltage and rated in kilovolts and amperage.

To perform this task, follow these steps:

NOTE:
This FULL LOAD CURRENT is multiplied by 1.5, 2.0, 2.4, and 3.0 depending upon kVA rating of transformer. This is computed by the engineers. **IF THIS IS FIGURED BY THE ENGINEERS THEN DON'T BOTHER WITH THE INFORMATION.**

Step 2: Installing Protective Equipment

- The lightning arrester and fuse cutouts are installed on either a crossarm, standoff, or auxiliary arm.
- An accessory arm is a crossarm installed below the primary circuit.
- The distance below is determined by the engineers that design the distribution circuit.
- Standoff and other accessory epoxy arms are installed with a through-bolt and lag screw.
- Mounting brackets for crossarm installation are L-shaped brackets.
- These are attached with two carriage bolts and by squeezing the crossarm.
- The standoff mounting bracket for the protective devices is a flat metal bar with holes for mounting.
- The handline is installed above the work position to allow easy access to equipment that is sent up the handline.
- The crossarm is raised to the proper location and installed.
- The standoff is installed just like armless construction.
- The protective devices should be attached to their brackets before being raised.
- Make sure the knot used to raise the protective devices is secure.

- The groundman raises the devices up and the linemen installs the devices to the arm.
- The fuse cutouts should be installed so the barrels will open away from the transformers.
- Also the fuse cutout should be angled toward the pole to make it easy for linemen on gaffs to open.
- The protective device should be as close under the phase it is connected to as possible.
- Repeat the procedure until all the required protective devices are installed.

Step 3: Connecting.

- Once installed on the accessory arm, the protective devices can be connected to overhead lines and equipment.
- The bottom of the fuse cutout goes to the H1 bushing of the transformer
- The bottom of the lightning arrester goes to the pole ground.
- The wire is connected to the top of the fuse cutout.
- The wire is then connected to the top of the lightning arrester.
- This wire is fastened to a hotline clamp which is secured to a hotline stirrup.

SAFETY:
THE GROUNDMAN SHOULD NOT STAND UNDERNEATH ANY SUSPENDED OBJECTS. MAKE SURE KNOTS THAT RAISE EQUIPMENT ARE TIED PROPERLY TO SUPPORT THE WEIGHT. EVERYONE WORKING THE JOB SHOULD MAKE SURE THE LINES ARE PROPERLY DE-ENERGIZED BEFORE BEGINNING WORK.

NOTE:
Transformers must be protected from overvoltage and overcurrent conditions. Lightning arresters and fuse cutouts are two devices used for protection. Fuses come in type K (kwick) and type T (tardy). The devices can be installed on either a crossarm, standoff, or auxiliary arm. Again, be sure wires are de-energized before beginning work.

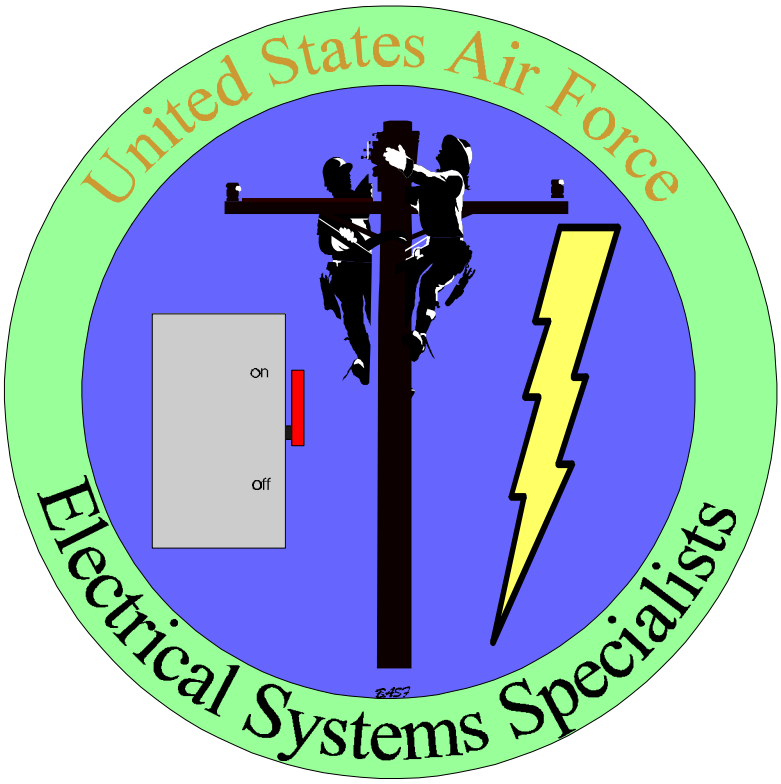
Review Questions
for
Protective Devices

Question	Answer
1. Transformers must be protected from.	a. Overrating b. Overvoltage c. Overcurrent d. Both B and C
2. Lightning Arresters provide _____ protection.	a. Overcurrent b. Overvoltage c. Overheating d. None of the above
3. Fused Cutouts provide _____ protection.	a. Overcurrent b. Overvoltage c. Overheating d. None of the above
4. The lightning arrestor is installed on the crossarm only.	a. True b. False
5. An accessory arm is a crossarm installed below the primary circuit.	a. True b. False
6. The handline is installed _____ the work position to allow easy access to equipment that is sent up the handline.	a. Above b. Below c. Near d. Around
7. Once installed on the accessory arm, the protective devices can be connected to the overhead lines and equipment.	a. True b. False
8. The groundman should not stand underneath any suspended objects.	a. True b. False

PROTECTIVE EQUIPMENT

Performance Checklist		
Step	**Yes**	**No**
1. Can trainee determine the full load current using formulas?		
2. Did trainee properly install the fused cutout?		
3. Did trainee properly install the lightning arrestor?		
4. Did trainee properly connect the fused cutout and the lightning arrestor in the circuit?		

FEEDBACK: Trainer should provide both positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the mind of both the trainee and trainer.



INSTALL:

MODULE 16 **AFQTP UNIT 4**

SERVICE DROPS (16.4.7.)

Notice. This AFQTP is *NOT* intended to replace the applicable technical references nor is it intended to replace hands-on training. It is to be used in conjunction with these for training purposes only.

SERVICE DROPS

Task Training Guide

STS Reference Number/Title:	16.4.7. – Overhead distribution systems, install service drops
Training References:	• CDC 3E051A, Vol. 4
Prerequisites:	• Possess as a minimum a 3E031 AFSC.
Equipment/Tools Required:	• General tool box • Personal safety equipment • Hi-Reach truck or personal climbing equipment
Learning Objective:	• Given equipment, install service drop
Samples of Behavior:	• Following approved methods, install service drop • Know safety requirements associated with installing service drop
Notes:	
• Any safety violation is an automatic failure.	

SERVICE DROPS

- **Background:** Power needs a path from the distribution system to the building structure. The service drop provides this path using conductors connected from the secondary of the transformer to the service entrance of the building. It may consist of two, three, or four wires either individually hung or a multi-conductor cable that uses a carrier cable for support. The service drop has a specific size and distance it can run and a height specification determined by location and voltage. If a large wire size is needed, you may have to use individual conductors. For smaller size wires, you can use the multi-conductor cables (plex).
  Plex conductor is usually one bare ACSR neutral conductor wrapped by insulated phase conductors. Duplex is two-conductor, one bare, one insulated; and is used most for 120 volt services such as street lights. Triplex is supplied to most houses. This provides 120 and 240 volts for light and heavy appliances. This consists of two insulated conductors wrapped around one bare conductor. Quadraplex is supplied to customers that require three-phase power and lights. It consists of three insulated conductors and one bare conductor
  Service drops should be less than 100 feet in length for wire sizes No. 2, 4, and 6. When using wire size 1/0 or larger the span should not exceed 75 feet. However, longer spans are permitted if the service pole is specially anchored and the using installation (building or pole) is strong enough to support the weight of the conductors.
- The attachment devices that the conductor attaches to are numerous. Spool racks are vertical rows of spool insulators placed on steel support that separates the spools and provides attachment to poles or other supports.
- Spool racks are used mostly for single conductor support. A clevis is a spool insulator in a metal, U-shaped bracket that attaches to its support with throughbolts or lag screws. Clevises support plex conductors and are the most commonly used service drop support. J-hooks are lag screws with the head curved so that it resembles a “j”. These are driven into the pole. A wedge clamp is attached to the bare conductor of the plex bundle. The bail of the wedge clamp is looped over the j-hook. House knobs are small insulators either screwed in like a lag screw or clamped around a pipe. These are designed for small size conductors. They cannot withstand large strains. The wire attachment device hooks to the conductor and the attachment device. The wedge clamp is wedge shaped steel with a wedge-shaped sliding sleeve that tightens a conductor as strain is placed on it. These have wire that fastens/unfastens to allow attachment to the spool insulator and other devices. They are sized according to the conductor. Split bolts are used to clamp the conductor together around the attachment device.

NOTE:
These devices must be compatible to the conductor material so no corrosion will occur.

Quite often you will use the service mast to anchor the service drop.
The attachment point must not be less than 10 feet above ground, sidewalk level, or a platform, and it must not be closer than 3 feet horizontally to a window, porch, or fire escape. Conductors attached above a window are considered out of reach of the window and do not have to meet a distance requirement.
Connect the service entrance conductors to the service drop conductors using split bolts or other types of pressure connectors, starting with the neutral.

If the service drop conductors are aluminum, special connectors are needed to prevent electrolytic corrosion from taking place between the aluminum and the copper service conductors.

Before you attach the service drop to the pole, you need to make sure the proper clearances are met. The service drop cannot pass closer than 8 feet above a flat rooftop or less than 3 feet over the peak of a roof of less than 4 inches per foot. The attachment point must not be less than 10 feet above ground or sidewalk level.

The minimum clearance for service drops over residential property and driveways, and commercial areas not subject to truck traffic is 12' above grade. If it crosses a street or alley, the minimum clearance is 18 feet.

To perform the task, follow these steps:

Step 1: Determine wire size for service drop.

- Calculate the load and determine the wire size needed.

Step 2: Determine distance of service drop.

- Measure the distance from the secondary connections to the service entrance and cut the appropriate length of wire.

NOTE:
Service drop spans should not exceed 125 feet without intermediate poles.

NOTE:
Be certain to cut enough extra wire to make your connections and form drip loop at the service entrance.

Step 3: Make your connections at the service entrance.

- Multi-conductor cables are attached to buildings or other structures by fittings approved for the purpose.
- Individual conductors are attached to approved fittings or to porcelain insulators firmly anchored to the building or other structure.
- Connect the phases and neutrals together using an approved and properly sized connector.
- Tape the connectors and wire ends on the insulated conductors after the splice is complete. Do not bother to tape the neutral if it is a bare wire.
- Form a drip loop before the conductors enter the weatherhead. This prevents water from running down the service conductors into the weatherhead when it rains.

NOTE:
Be sure to get the aluminum conductor in the proper space in these connectors.

Step 4: Make connections at transformer.

- Using the high reach or climbing the pole with your personal climbing equipment, you can attach the conductors to the pole using the same type of fittings as previously discussed in Step 3.
- Pull the wire up until you have the proper clearance and cut off any excess. The sag in the service drop is done by hand, otherwise too great of a strain is placed on the service pole.
- Once the proper sag is placed on the conductor, it is attached to the utility pole's attachment device.
- Connections can be made directly into the secondary side of the transformer or if the transformer feeds multiple facilities, you may have to tie into a secondary line with pressure connectors (crimps, split bolt, etc.).
- When making connections at the transformer be sure the transformer has been isolated on the primary side.
- Connection procedures are the same as in step 3.

SAFETY:

ALWAYS BE AWARE OF YOUR SURROUNDINGS WHILE WORKING NEAR ENERGIZED LINES, REMOVE ALL JEWELERY BEFORE BEGINNING ANY WORK, AND WEAR PROPER SAFETY GEAR (HARD HAT, GLOVES, AND SAFETY HARNESS).

Review Questions
For
Service Drops

Question	Answer
1. What is the minimum clearance above the ground that the service drop may be attached to a building?	a. 8 feet b. 10 feet c. 12 feet d. 15 feet
2. How far must a service drop clear an alley?	a. 10 feet b. 12 feet c. 15 feet d. 18 feet
3. When a service drop is attached to the side of a building, how far must it be away from the side of a window?	a. 3 feet b. 4 feet c. 5 feet d. 10 feet
4. The maximum distance for a service drop with a wire size No. 2 is 100 feet.	a. True b. False
5. Triplex has ____ insulated conductor(s) wrapped around ___ bare conductor(s).	a. 3, 1 b. 1, 3 c. 2, 0 d. 2, 1
6. A service drop using 1/0 or larger wire should not exceed a maximum distance of ____ feet?	a. 50 b. 75 c. 100 d. 125
7. What is done at the service entrance to prevent water from entering the weatherhead?	a. Tape the weatherhead b. Use approved sealant c. Form a drip loop with the conductors d. None of the above
8. What is used to sag the service drop?	a. Winch b. Block and Tackle c. Only done by hand d. All of the above
9. What is the minimum distance above a window that the service drop must be attached?	a. 3 feet b. 5 feet c. 10 feet d. There is no minimum distance required

SERVICE DROPS

Performance Checklist		
Step	**Yes**	**No**
1. Did the trainee measure the proper distance for the service drop?		
2. Did the trainee use the appropriate attachment fittings?		
3. Did the trainee maintain the proper clearances?		
4. Did the trainee tape the connections?		
5. Did the trainee form a drip loop at the service entrance?		

FEEDBACK: Trainer should provide both positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the mind of both the trainee and trainer.

INSTALL:

MODULE 16 **AFQTP UNIT 4**

GROUNDING SET (16.4.9.)

Notice. This AFQTP is *NOT* intended to replace the applicable technical references nor is it intended to replace hands-on training. It is to be used in conjunction with these for training purposes only.

GROUNDING SET

Task Training Guide

STS Reference Number/Title:	16.4.9. – Overhead distribution systems, install grounding set
Training References:	• CDC 3E0X1 Set B Vol. 1 • AFI 32-1064 • AFH 32–1011
Prerequisites:	• Possess as a minimum a 3E031 AFSC.
Equipment/Tools Required:	• Grounding set • Grip-all stick
Learning Objective:	• Given equipment, install grounding set on overhead lines
Samples of Behavior:	• Follow approved steps and install grounding sets • Trainee should know safety requirements associated with installing grounding sets
Notes:	
• Any safety violation is an automatic failure.	

GROUNDING SET

Background: Whenever possible, we de-energize lines before we work on them. Before you work on de-energized lines, test for any potential and proper grounding. Air Force grounding devices must have clamps permanently attached to the cable. Even when line terminals have grounding switches for preliminary grounding, you must use an approved grounding set. Grounding devices must be large enough to carry the induced current and maximum fault current that could flow at the point of grounding for the time necessary to clear the line. Clamps attached to the "hot end" of the cable may have insulated sticks permanently attached or be operated by an insulated grip-all or rigid splice stick. The grounding cable must be 600-volts insulated rubber or synthetic-covered flexible copper. Figure 1 shows one type of approved grounding set used in group grounding method.

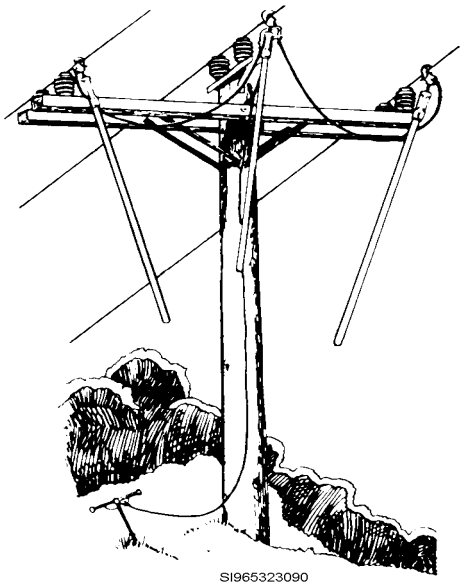


Figure 1, Installed grounding set

Installing grounds at the work site will protect you from induced voltages, static, and accidental energizing of the line.

When you have a de-energized line that is in close proximity to current carrying conductors, the magnetic field from the energized conductors can induce a voltage on your dead line, much like a transformer induces voltage from the primary winding to the secondary. A grounding set protects you from these induced voltages.

Whenever there is contact and separation of two dissimilar materials, static electricity is generated. Dust particles blown by the wind contact and separate with the conductor, generating static. If we have several miles of line de-energized under a safe clearance, the static that it generates could be considerable. Grounding prevents the build-up of these static charges.

The most important reason you need to always short and ground the lines you're working on is to provide protection from the hazard of accidental electrocution. This could happen if someone ignores the AF Form 979 and closes a switch that energizes the line you're working on. On emergency generators grounding sets come in many styles, but all are designed to short the phases together and then take them to ground. The grounding set is there to protect you.

To perform the task, follow these steps:

Step 1: Perform circuit safety check.

- Open the circuit.
- Use whatever means appropriate to open the circuit, such as circuit breakers, air switches, or disconnect switches.
- Block these switches.
- Tag circuit. The proper tag (AF Form 979 or 980) should be placed on the switches.
- Make voltage checks. Use an approved voltage tester to check for voltage before installing grounds.

SAFETY:
NEVER USE HOT-LINE CLAMPS INSTEAD OF GROUND CLAMPS. GROUNDING DEVICES MUST BE OF SUCH SIZE AS TO CARRY THE INDUCED CURRENT AND MAXIMUM FAULT CURRENT THAT COULD FLOW AT THE POINT OF GROUNDING FOR THE TIME NECESSARY TO CLEAR THE LINE.

NOTE:
Some line terminals, provided with grounding switches, should be used for preliminary grounding, but their use does not waive application of cable or clamp grounding devices.

NOTE:
Clamps used in grounding sets must be of the best construction, and maintained properly. Clamps on the "HOT" end of the cable may have insulated sticks permanently attached or be operated by using an insulated "shotgun" or rigid splice stick. Cables must be 600 volt insulated rubber or synthetic covered flexible copper.

Step 2: Install ground set.

- A ground set must be grounded securely before you make connections to the conductors.
- You can use grounding points such as a static wire, primary neutral, or steel tower if they are large enough to carry the induced fault current.
- Clean the conductor surfaces with a wire brush mounted on a universal stick before installing the ground set.
- The neutral is always grounded first, then a phase wire is grounded.
- After this has been accomplished, attach the free clamps of the device to the nearest conductor, using an insulated stick and making the contact firmly.
- Phase-to-phase jumpering is the best protection after one phase has been grounded.
- When performing work at more than one location in a line section, ground and short circuit one location in the line section.
- The conductor being worked on must be grounded at each work location.

NOTE:
N Never place a ground clamp over an armor rod. Ground sets must be installed on either side of the h work location, as close as possible to the work, or a single ground point shall be placed at the work location. The exterior electrical supervisor must be advised when and where the grounds are placed and when removed.

SAFETY:
If GROUND SET IS INADVERTANTLY PLACED ON ENERGIZED CIRCUIT, DO NOT REMOVE (DANGEROUSE ARCH AND OTHER UNSAFE CONDITIONS COULD RESULT). ALLOW CIRCUIT TO TRIP WITH PROTECTIVE DEVICES.

Step 3: Removal of ground set.

- Remove grounds in the reverse order, starting with the conductor clamp that's farthest away.

SAFETY:
WHEN A LINE IS BEING WORKED ON, OR IS PARALLEL TO AN ADJACENT ENERGIZED LINE; WHEN IT'S SUBJECT TO OTHER ENERGIZED LINES CROSSING OVER OR UNDER; OR WHEN IT'S SUBJECT TO HIGH FAULT CURRENTS, IT MAY BE PRACTICAL TO GROUND AT THE POINT OF WORK. REGARDLESS, ALL LINES MUST BE GROUNDED OR SHORT-CIRCUITED. GROUNDING THE DE-ENERGIZED CONDUCTORS PROTECTS LINEMEN IN CASE A SWITCH IS CLOSED ACCIDENTALLY OR AN ENERGIZED CIRCUIT COMES IN CONTACT WITH THE DEENERGIZED LINE. FOR MORE DETAILED INFORMATION ON GROUNDING, CHECK AIR FORCE HANDBOOK 32-1011, ELECTRICAL WORKER FIELD SAFETY GUIDE.

NOTE:
A good method of testing a supposedly dead circuit or piece of equipment is by using a "high voltage phasing tester," or similar device.

Review Questions
for
Grounding Set

Question	Answer
1. What must be accomplished before you work on de-energized lines?	a. Nothing b. Ground and test ground c. Test for voltage and ground d. Inform superintendent of installation of ground sets.
2. Installation of ground set protects workers from _____.	a. Induced voltage b. Static c. Accidental energizing of the line d. All of the above
3. The first step in performing a circuit safety check is _____.	a. Block the switches b. Open the circuit c. Test for voltage d. Install ground
4. Hot line clamps and grounding clamps are interchangeable.	a. True b. False
5. Cables used in grounding must be _____.	a. 600 volts b. 600 volt insulated rubber c. 600 volt Synthetic covered flexible copper d. All of the above
6. The use of line terminals provided with ground switches waives the use of grounding sets.	a. True b. False

GROUNDING SET

Performance Checklist		
Step	**Yes**	**No**
1. Did trainee perform a circuit safety check?		
2. Did trainee ground the neutral before the phase wires?		
3. Did trainee clean conductor before installing the ground set?		
4. Did trainee properly connect all the remaining phases?		
5. Did trainee remove grounds in reverse order, starting with the conductor clamp farthest away?		

FEEDBACK: Trainer should provide both positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the mind of both the trainee and trainer.

OVERHEAD DISTRIBUTION SYSTEMS

MODULE 16 **AFQTP UNIT 5**

INSPECT POLES AND INSTALLED EQUIPMENT (16.5.)

Notice. This AFQTP is *NOT* intended to replace the applicable technical references nor is it intended to replace hands-on training. It is to be used in conjunction with these for training purposes only.

INSPECT POLES AND INSTALLED EQUIPMENT

Task Training Guide

STS Reference Number/Title:	16.5. – Overhead distribution systems, inspect poles and installed equipment
Training References:	• AFI 32-1064, Electrical Safe Practices • AFMAN 32-1080, Electrical Power Supply and Distribution • CDC 54250B Vol. 1, Substation Equipment and Overhead Systems
Prerequisites:	• Possess as a minimum a 3E031AFSC.
Equipment/Tools Required:	• Personal Climbing/Protective Equipment • Binoculars • Hammer / Screwdriver • Shovel
Learning Objective:	• Given equipment, safely perform an inspection of an overhead distribution system poles and installed equipment on the poles.
Samples of Behavior:	• Following approved methods, perform an inspection of an overhead distribution pole • Following approved methods, perform an inspection of installed equipment • Know safety requirements associated with inspection of overhead distribution pole and installed equipment
Notes:	
• To successfully complete this element, the steps must be followed exactly--no exceptions. • Any safety violation is an automatic failure.	

INSPECT POLES AND INSTALLED EQUIPMENT

Background: One major task that you will perform as a lineman is maintaining systems already installed. This unit will cover maintenance procedures for a distribution line. An adequate supply of dependable electrical power is essential for the accomplishment of an installation's mission. Adherence to a well-organized maintenance program, including the establishment of specific goals and follow-up procedures, will assure the proper functioning of the equipment in the distribution system. This program should include the scope of work, intervals of performance, and methods of application. When a number of items require servicing or renewal over a period of years, a proportionate number should be serviced each year. For instance, if there are 100 transformers on the system, requiring maintenance at 5-year intervals, the work should be performed on 20 transformers each year.

Before attempting to perform maintenance on any portion of a distribution system, you must isolate that portion. A schedule for pole inspection should be established for each installation. The frequency of inspections should be based on local conditions and past experience.

To perform the task, follow these steps:

Step 1: Isolate the circuit.

- Initiate and follow all safe clearance procedures.
- De-energize the line, then block and tag.
- Make a voltage check to make sure the line is de-energized, then ground the line.

NOTE:
During inspections the line may be energized, use caution as you come near the lines.

Step 2: Inspect poles.

- Inspect all the hardware that is attached**.**
- Look for blown fuses, equipment-leaking oil, and discolored metal around connections, pole guards broken or damaged, and broken or cracked insulators.

NOTE:
Anything that appears out of normal should be reported and recorded.

Step 3: Inspect poles (Above Ground).

- Above ground, check poles for decay, scaling of the outer surface, large cracks, excessive leaning, splits, electrical burns, or any other mechanical damage.
- Sound the pole all the way to the top with a hammer to check for heart rot.
- As you ascend the pole, tighten all the hardware.

SAFETY:
IF THERE IS ANY DOUBT ABOUT THE SOUNDNESS OF A POLE, IT SHOULD BE TESTED FOR HEART ROT.

Step 4: Inspect poles (below ground).

- Below ground, bore a hole 1/2 inch below ground line and at a 45° upward angle into the pole with a bit. If the bit breaks through to the center of the pole, it is evidence of heart rot.
- If the pole shows no evidence of rot, plug the hole with a 3/8 in. treated dowel to keep moisture out and prevent further decay.
- If the pole is defective, take whatever means necessary to replace.

NOTE:
It is a good idea to list all discrepancies for follow-up maintenance after the inspection. Also, when you inspect the line, you should start at the source or the load and walk the system out to check it correctly. The discrepancies should be reported on a pole log.

Step 5: Inspect conductor support devices (Crossarms).

- Inspect crossarms for decay, weathering, and twisting.
- Decay usually starts at the pin holes and can best be detected with a probe.
- If warranted by a visual inspection, probe the arm enough to determine the extent of the decay.
- If cracks are near through-bolt or dead-end bolts, replace the arm because the crack may allow the bolt to pull through the crossarm.

NOTE:
Where twisted arms impair the safety of the line or create an unsightly appearance, the condition should be corrected.

Step 6: Inspect conductor support devices (Armless).

- When inspecting vertical construction, look for any cracks on the arm or any other sign that the arm is damaged.
- Seeing uneven stress on the conductors can be a sign of problems.
- Look for damage to the arms.
- Ensure all mounting hardware is tight.

Step 7: Inspect conductor support devices (Insulators).

- Look for fractures, chips, deposits of dirt, salt, cement dust, acid fumes, or foreign matter which under moist conditions may cause a flashover.
- Check for cracks in porcelain insulators by tapping gently with a small metal object about the size of a 6" wrench. If the main body or skirt of a porcelain insulator is cracked or damaged, replace the insulator.
- If loose cement permits movement between porcelain and metal parts, replace the insulator.

NOTE:
Insulators free of cracks emit a ringing sound when tapped, cracked ones sound dull and hollow. To avoid damaging good insulators, tap them, DO NOT hit them hard.

SAFETY:
SINCE THE INSULATING QUALITIES OF PORCELIN INSULATORS AND THEIR ABILITY TO PREVENT FLASHOVERS DEPEND LARGELY ON THE GLASS-LIKE GLAZE OF THE SURFACE, CARE MUST BE TAKEN IN CLEANING TO PRESERVE THIS SMOOTH SURFACE AND PREVENT IT FROM BECOMING DULLED OR SCRATCHED.

Step 8: Inspect distribution transformer (External).

- Check for blown fuses and defective lightning arrestors.
- Ensure lighting arrestors and fuse cut-outs are secured and have no broken insulation or connections.
- Inspect bushings for cracks or loose connections. A sign of loose connections is discolored wire.
- Check the case for leaking oil, loose lid, missing nameplate, hardened bushing gaskets, corroded or broken ground connections, rusting of tanks, and signs of corrosion on terminals, bushing studs, and connectors.

NOTE:
If the transformer is excessively noisy or has a ruptured gasket, then the unit should be opened, internally inspected, and tested. Before these items can be replaced or reported, these conditions should be recorded.

SAFETY:
ALWAYS DE-ENERGIZE AND GROUND LINE BEFORE BEGINNING WORK.

Step 9: Inspect distribution transformer (Internal).

- Check all connections inside the transformer for any signs of excessive heating (discoloration) including the tap charger assembly.
- Inspect for any corrosion of all the internal components.
- Ensure that none of the bushings are broken or have defective gaskets.
- Check the level of the insulating oil, and since the transformer is open, test the oil.

NOTE:
Oil samples should be taken from each oil-insulated distribution transformer of 100 kVA capacity and over and given a dielectric test at five year intervals.

- If an oil-insulated transformer has been out of service for one year or more, obtain an oil sample (oil must stand 24 hours before being tested) and give it a di-electric test before re-energizing the transformer.

Step 10: Inspect distribution transformer (Load Test).

- A load test should be made annually on transformers which supply a load that is known to be increasing. Transformers which supply a steady connected load should be load tested every five years. Load tests should be made with portable ammeters (dial-indicating or recording-chart type), installed for at least 24 hours on the day during the peak loading period. Determine this day by spot checking with a clamp-on ammeter. Reasonable accuracy and complete safety are of the greatest importance in making transformer load surveys. Readings are taken on the secondary side of the transformer whenever possible. Testing all transformers may not be necessary because similar areas and buildings may have quite similar loads.

Step 11: Inspect protective devices (Fuse Cut-Outs).

- Contacts should be kept clean and bright.
- If the fuse cut-out hasn't opened/closed in a long time, inspect periodically to guard against oxidation.
- Contact clips and ferrules can be covered with a special non-corrosive conductive lubricant.
- Operating mechanisms should be inspected and lubricated as required.
- Inspect insulating portions for any cracks or chips.
- Replace if damaged.

Step 12: Inspect protective devices (Lighting Arrestors).

- Most lightning arrestor maintenance consists of visual inspection of the insulating portion and for tight connections. Because of the nature of these devices, it is recommended that units found to be defective be replaced rather than repaired.

Step 13: Inspect air switches.

- If the circuit can be de-energized, the switch should be opened and closed a number of times so that the adjustment of the operating mechanism can be observed.
- Terminals should be checked to ensure they are secure.
- High resistance connections showing evidence of heat should be corrected.
- The blade or moveable contact of the switch should be inspected for evidence of overheating which may be indicated by discoloration.
- If overheating is caused by poor contact, it should be corrected when contacts are adjusted and cleaned.

NOTE:
Switches that appear to be overheated due to load currents in excess of rating should be reported to the supervisor.

- A blade latch is used on a hook stick operated switch to hold blade in closed position. Such a switch should be checked in the closed position to determine whether the catch is functioning properly.
- Contacts should be cleaned and adjusted in accordance with manufacturer's instructions.
- After a switch remains in either position for a long time, it should be operated several times during a maintenance inspection for the purpose of cleaning the contact surfaces after getting clearance and after the circuit has been de-energized.

NOTE:
Do not use a coarse abrasive to clean contacts.

- Where arcing horns are used, make sure they make contact as intended during opening and closing operations.
- A non-oxidizing lubricant should be used to protect the contacts against oxidation and to lubricate the blade hinge.

NOTE:
Silicone greases are excellent for this purpose as they are relatively unaffected by change in temperature and are highly water-resistant.

Step 14: Inspect operating mechanisms.

- Check the adjustment of the operating mechanism, operating rod, and interphase tie rods (if used) to ensure simultaneous and smooth operation of the switchblades.
- Mechanism should be lubricated in accordance with the manufacturer's instructions.
- Examine all metallic parts of operating mechanism for signs of rust, corrosion, and loose or broken connectors.
- Check connection to operating handle in the same manner.
- The complete electrical circuit of motor operated mechanisms should be checked to ensure proper operation and that all wires are secure and free of insulation defects.

SAFETY:
SWITCHES LOCATED OUTSIDE A FENCED AND LOCKED AREA THAT HAVE OPERATING HANDLES AT GROUND LEVEL,MUST HAVE PROVISIONS ON SUCH HANDLES FOR LOCKING THE SWITCH IN BOTH THE OPEN OR CLOSED POSITION. WHEN LOCATED WITHIN A FENCED AND LOCKED AREA, THE REQUIREMENT FOR LOCKING IS SUBJECT TO LOCAL REGULATIONS.

Step 15: Inspect interrupting elements.

- Interrupters should receive the same inspection and maintenance as the switches on which they are installed.
- Interrupter contacts should be inspected for damage caused by arcing.
- Contacts showing evidence of excessive wear should be replaced in accordance with manufacturer's recommendations.
- Interrupters having a sealed, gas-filled chamber, have a pressure gauge which will indicate loss of pressure. Field experience indicates that interrupters using sealed gas chambers will require recharging every two and one-half to three years or more often.

Step 16: Inspect oil switches.

- The mechanism should be checked to see that all contacts and connections are in good operating order.
- All loose nuts and screws should be tightened.
- Pits on contacts should be removed with fine sandpaper if they are not too deep.
- Badly pitted contacts should be replaced.
- Alignment should be checked to ensure good contact pressure when the switch is closed.
- The switch should be closed by hand to make certain that it operates freely.

- As with any electrical equipment, if any discrepancies are found on the equipment ground, it should be corrected immediately.
- Before the cover or tank is replaced, gaskets should be inspected to ensure a good seal.
- If the gasket has been damaged, replace it.
- Bushings should be cleaned by wiping with a cloth.
- Ensure the case is connected to ground.
- Look for anything out of the ordinary.

Step 17: Inspect vacuum switch.

- Vacuum switches should be inspected and maintained in accordance with the manufacturer's recommendations.

Step 18: Inspect automatic recloser.

- Inspect tank for rust and leaking oil and the bushings for cracks and flashover.
- Check connections for tightness and ensure case is grounded.
- Look for anything out of the ordinary.

NOTE:
Scheduling maintenance on recloser is dependent primarily on the severity and number of reclosing operations incurred and the dielectric strength of the insulating oil.

SAFETY:
FOLLOWING ALL SAFE CLEARANCE PROCEDURES AND CONDUCTING IN-DEPTH BRIEFINGS WILL HELP ENSURE SAFE COMPLETION OF THE INSPECTION AND MAINTENANCE OF DISTRIBUTION EQUIPMENT. ALWAYS REMEMBER TO FOLLOW MANUFACTURER'S SPECIFICATIONS AND RECOMMENDATIONS.

Review Questions
for
Inspect Poles and Installed Equipment

Question	Answer
1. Distribution lines should be inspected at scheduled intervals not to exceed ____ years.	a. 1 b. 3 c. 4 d. 5
2. Hardware on Wooden poles are inspected for _____.	a. Blown fuses b. Equipment leaking oil c. Discolored metal around connections d. All of the above.
3. Wooden crossarms are inspected for ___.	a. Decay around pin holes b. Cement dust c. Twisted guy wires d. Ring sound when tapped
4. Insulators should have a _____ surface to prevent flashover.	a. Dull surface b. Glass like glaze c. Tapered finish d. All of the above
5. What do you inspect a transformer case for?	a. Blown fuses b. Loose connections c. Leaking oil d. Oil level
6. During load tests portable ammeter should be installed for at least _____ hours on the day during peak loading period.	a. 6 b. 12 c. 24 d. 48
7. Contact clips and ferrules can be covered with a special non-corrosive conductive lubricant.	a. True b. False
8. When performing a visual inspection of lightning arrestors, what are you looking for?	a. Signs of excessive heating b. Clean and bright connections c. Tight connections d. All of the above
9. If the line can be de-energized how can you clean contacts of an air break switch?	a. Non-corrosive lubricant b. Non-conductive lubricant c. Opening and Closing switch d. Emory cloth
10. Replacement of bad gaskets found during inspection of oil filled equipment is not required.	a. True b. False

INSPECT POLES AND INSTALLED EQUIPMENT

Performance Checklist		
Step	**Yes**	**No**
1. Did the trainee inspect all hardware attached to pole during pole inspection?		
2. Did the trainee sound pole all the way to the top with a hammer to check for heart rot?		
3. Did the trainee inspect crossarm for decay around pinholes?		
4. Did the trainee inspect insulator for fractures, chips, deposits of dirt, salt, acid fumes, or foreign matter?		
5. Did the trainee inspect transformer casing for leaking oil, loose lid, missing nameplate, hardened bushing gaskets, corroded or broken ground connections, and signs of corrosion on terminals?		
6. Did the trainee inspect protective devices to ensure they are secure, checking for evidence of rust and corrosion and ensure proper alignment and tightness of fittings?		
7. Did the trainee use binoculars to aid in inspection of air switches?		
8. While inspecting operating mechanisms did the trainee check the complete electrical circuit to ensure proper operation and that all wires are secure and free of insulation defects?		
9. Did the trainee tighten all loose nuts and screws while inspecting oil switches?		
10. Did the trainee follow all safe clearance procedures while performing inspection and maintenance of distribution equipment?		

FEEDBACK: Trainer should provide both positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the mind of both the trainee and trainer.

OVERHEAD DISTRIBUTION SYSTEMS

MODULE 16 AFQTP UNIT 15

PERFORM TRANSFORMER CONNECTIONS (16.15.)

Notice. This AFQTP is *NOT* intended to replace the applicable technical references nor is it intended to replace hands-on training. It is to be used in conjunction with these for training purposes only.

TRANSFORMER CONNECTIONS

Task Training Guide

STS Reference Number/Title:	16.15. – Overhead distribution, perform transformer connections
Training References:	• CDC 3E051A Vol. 4
Prerequisites:	• Possess as a minimum a 3E031 AFSC.
Equipment/Tools Required:	• 2 ea. Adjustable Wrenches • 1 Volt/Ohm meter • knife to skin wire
Learning Objective:	• Given equipment, make proper transformer connections
Samples of Behavior:	• Following approved methods, make internal and external transformer connections to supply desired voltage • Recognize types of transformer connections • Know safety requirements for making transformer connections
Notes:	
• Any safety violation is an automatic failure.	

PERFORM TRANSFORMER CONNECTIONS

Background: Transformers have two sets of external bushings -- primary and secondary. A bushing is a metal rod that protrudes through a porcelain cylinder isolating it from the transformer case. The bushing hooks up to the internal primary and secondary windings.

The primary bushing is usually the larger of the two sets of bushings. Primary bushings are designated H_1, H_2, and H_3 from left to right. Primary bushings hook up to the line side or system high voltage.

Secondary bushings are designated X_0, X_1, X_2, and X_3. They are usually the smaller set and hooked to the load or low voltage side of transformer.

The internal connection of the transformer determines the rated voltage you can get from the transformer. The internal connections can be connected so you receive either one of the rated voltages or get two voltages from transformer. This is determined by customer needs.

The secondary windings in the transformer are marked with identification tags or stamped directly on the lugs with the letters A,B,C, &D. See Figure 1 below.

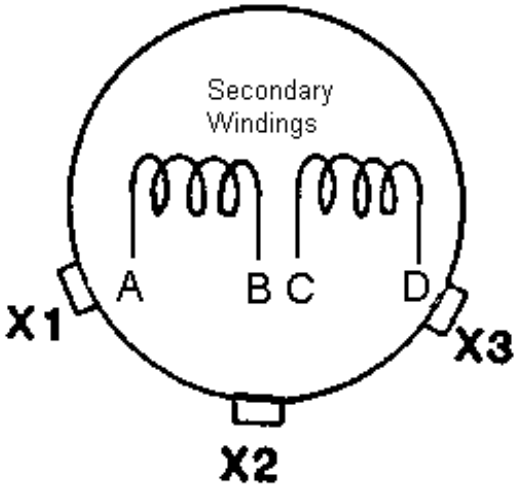


Figure 1, Secondary Windings Identification

Open connections serve two purposes. Emergency three-phase power on a three transformer bank where one unit has failed, and temporary operation of a transformer bank that is expected to grow at a later date. There are two types of open connections: Open-Delta and Wye-Open-Delta. Open connections have several inherent operating limitations. The main limitation is that the full KVA capacity of the two transformers can not be realized. In open connected banks, only 86 percent of the installed capacity of the transformers is realized. If two 50 KVA transformers are connected in Open-Delta or Wye-Open-Delta, they will only provide 86 KVA total capacity, not 100 KVA as would be expected. The capacity of an Open-Delta or Wye-Open- Delta bank is 58 percent of three transformers of the same size. Three 50 KVA transformers would have a total capacity of 150 KVA. This same bank, minus one unit, connected Open-Delta or Wye-Open-Delta would have a capacity of 86 KVA.

The Open-Delta connection is used on Delta/Delta banks where one transformer fails. Note that it has the same secondary connection as the Wye-Open-Delta bank. Open connections are not normally made for permanent installations. Most open connections are made for emergency power requirements so the original bank is already in place.

NOTE:
There are no emergency connections for Wye secondary three-phase transformer banks.

To perform these tasks, follow these steps:

SAFETY:
MAKE SURE THAT ALL TRANSFORMERS ARE DE-ENERGIZED BEFORE BEGINNING ANY TRANSFORMER CONNECTIONS.

Step 1: Internal Transformer Connections.

- Determine what voltage is needed from the transformer.
- Determine the existing wiring configuration of the transformer.
- Determine amperage requirements also.

NOTE:
You can test a pole type transformer to see if it is connected in series or parallel without opening the top. Using an ohmmeter, test for continuity between the bushings. If you have continuity (a reading of near zero) between all three secondary bushings, then it is connected in series. If you only have continuity between two of the bushings, X_1, and X_2, X_1, and X_3, or X_2, and X_3, it is connected in parallel.

Step 2: Connecting in parallel (Wye).

- Open Transformer Casing. The transformer is opened, by lifting the lid or access cover for access to the internal connections.
- For a parallel connection, see Figure 2.

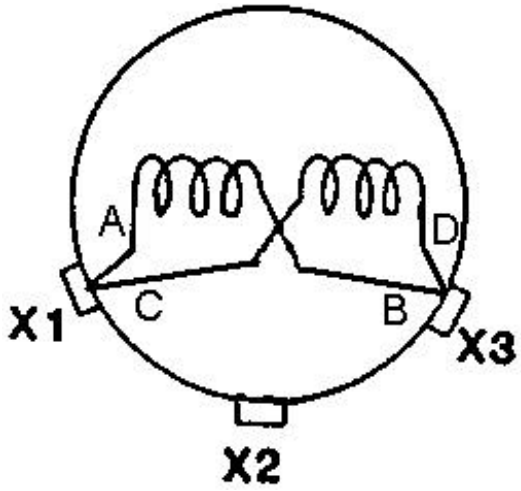


Figure 2, Parallel Connection

- Remove the retaining nuts and place leads A + C under the X_1 bushing and replace nuts.
- Remove the retaining nuts and place leads B + D under the X_3 bushing and replace nuts.
- The X- 2 bushing is not used in this connection.
- Replace lid or inspection cover.
- Your transformer is connected in parallel with a maximum output voltage of 120 VAC.
- The X_1 bushing is connected to a phase and the X_3 bushing is connected to neutral

NOTE:
Tie your wrenches to the outside transformer bushings or to your wrist with a small rope or twine and use both hands to unscrew the nuts holding the transformer leads to the bushings. Cup your free hand under the stud so if you do drop a transformer nut, it will fall into your palm. If you drop a wrench or a brass nut down in the transformer, it is nearly impossible to get it out without draining the transformer. Better safe than sorry.

Step 3: Connecting in Series (Delta).

- Open Transformer Casing. The transformer is opened, by lifting the lid or access cover for access to the internal connections.
- For a series connection, see Figure 3.

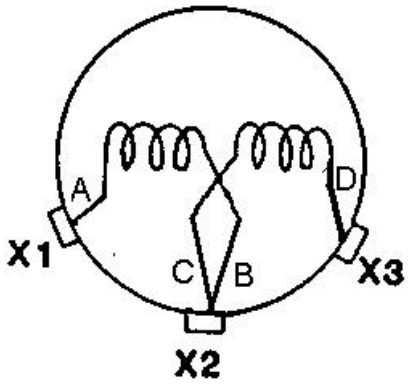


Figure 3, Series Connection

- Remove the retaining nut and place lead A under the X_1 bushing and replace nut.
- Remove the retaining nuts and place leads B + C under the X_2 bushing and replace nuts.
- Remove the retaining nut and place lead D under the X_3 bushing and replace nut.
- Replace lid or inspection cover.
- Ground the X_2 bushing (on transformers equipped with internal ground strap for bonding).
- Your 120/240 transformer is connected in series for a maximum of 240 volts between bushings X_1 and X_3, and 120 volts between bushings $X_1$and X_2 or 120 volts between X_2 and X_3.

Step 4: Primary Connections (**Single Phase Delta**).
- Connect the transformer H_1 bushing to a phase through a protective device (fuse).
- Connect the transformer H_2 bushing to a separate phase through a protective device (fuse).

Step 5: Primary Connections (**Single Phase Wye**).
- Connect the H_1 bushing to a phase through a protective device (fuse).
- Connect the H2 bushing to the system neutral.

NOTE:
Three Phase Transformer Banks. Three-single phase transformers can be connected together for three-phase power, or three energized legs. They are connected for Wye (parallel) or Delta (series). There are four basic configurations that the transformers can be connected. The four connections are:
a. Delta/Delta- Both primary and secondary connections are in series.
b. Wye/Wye- Both primary and secondary connections are in parallel.
c. Delta/Wye- Primary connection is series and secondary connection is in parallel.
d. Wye/Delta- Primary connection is in parallel and secondary connection is in series.

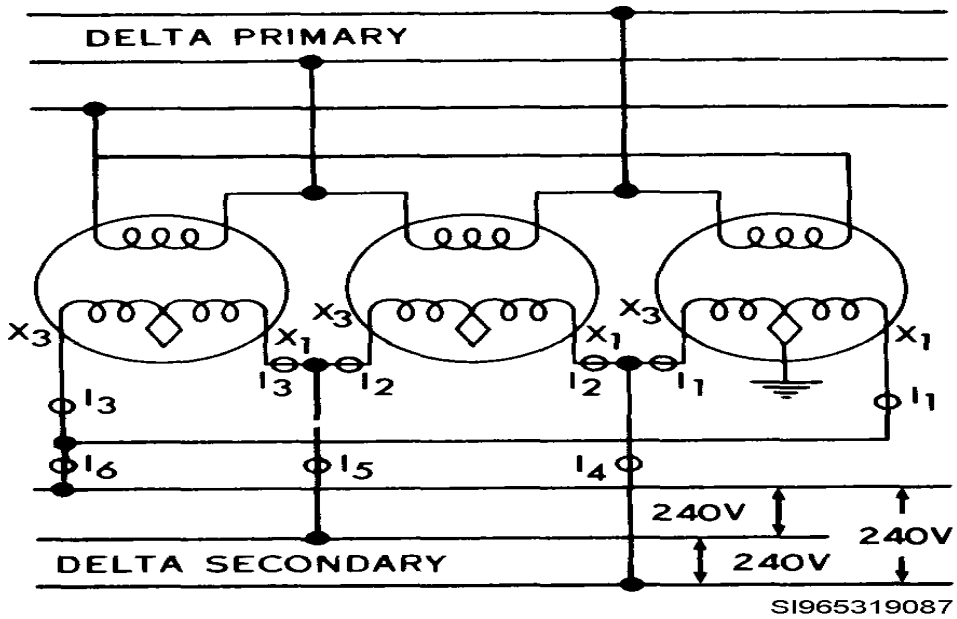


Figure 4, Delta/Delta For Power Only

Step 6: Primary Connection for a delta / as seen in Figure 4 above.

- Connect each transformer's H_1 bushing to a separate phase through a protective device.
- Connect each H_2 bushing to the next closest H_1.
- The last transformer's H_2 will go to the first transformers H_1.
- It should be arranged so each transformer has two different phases and each phase is used only twice.

Step 7: Secondary Connection for a delta / delta as seen in Figure 4 above.

- Connect each transformers X_1 bushing to a different secondary phase.
- Each X_3 (secondary) bushing is connected to the next closest X_1.
- The last transformer's X_3 will go to the first transformer's X_1.
- It should be arranged so each transformer has two different secondary phases and each phase is used only twice.

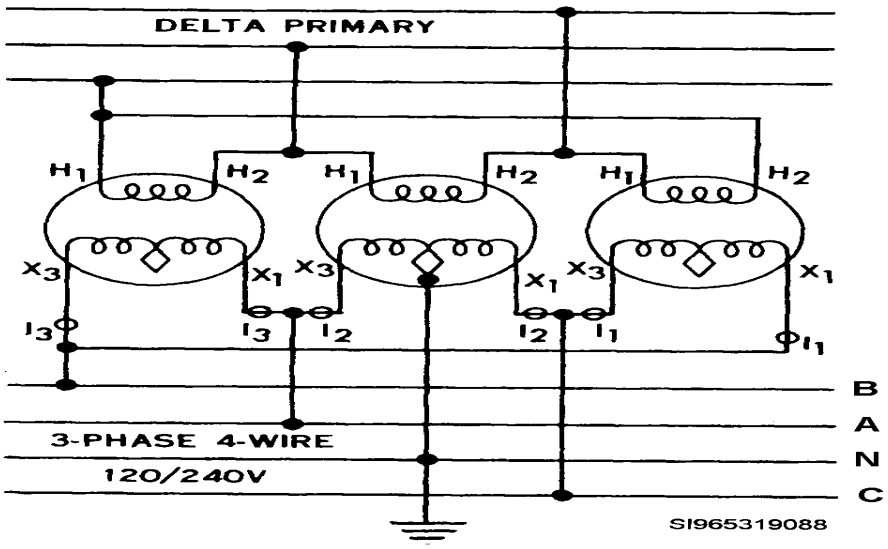


Figure 5, Delta/Delta for Lights and Power

Step 8: Primary Connection for a delta / delta as seen in Figure 5 above.

- Connect each transformer's H_1 bushing is to a separate phase through a protective device.
- Connect each H_2 bushing to the next closest H_1, the last transformer's H_2 will go to the first transformers H_1.
- It should be arranged so each transformer has two different phases and each phase is used only twice.

Step 9: Secondary Connection for a delta / delta as seen in Figure 5 above.

- Connect each transformer X_1 bushing (secondary) to a different secondary phase.
- Connect each X_3 (secondary) bushing to the next closest X_1.
- The last transformer's X_3 will go to the first transformer's X_1.
- It should be arranged so each transformer has two different secondary phases and each phase is used only twice.
- Ground the center X_2 bushing of the center transformer.

NOTE:
This connection is called a center tap. Center tapping one transformer provides the low rating of the secondary windings. This creates a condition known as a wild leg. This is an unusable voltage in relation to ground 180-210 volts. This is usually the farthest lead from the center tap; however, you must trace each phase lead through the transformers windings to determine which goes through three windings to be sure the right one is identified. The wild leg is marked with orange tape or paint so it is not used with neutral.

NOTE:
The only difference between the Delta/Delta for power and Delta/Delta for lighting and power connections is the grounding of the center tap (X_2) bushing of the center transformer.

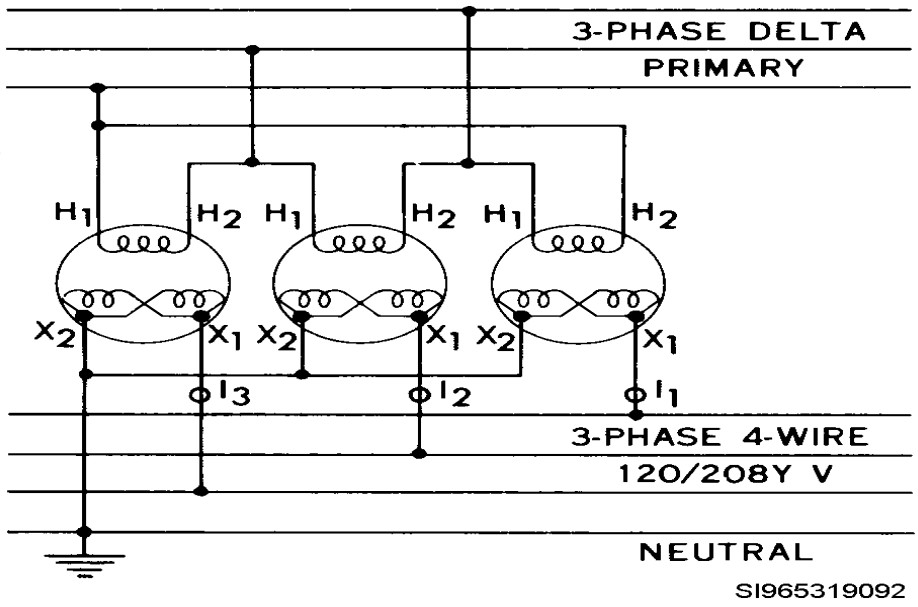


Figure 6, Delta/Wye Connection For Power And Lights

Step10: Primary Connection for delta / wye as seen in Figure 6 above.

- Connect each transformer's H_1 bushing is to a separate phase through a protective device.
- Connect each H_2 bushing to the next closest H_1.
- The last transformer's H_2 will go to the first transformers H_1.
- It should be arranged so each transformer has two different phases and each phase is used only twice.

Step 11: Secondary Connection for delta / wye as seen in Figure 6 above.

- Connect each X_1 bushing to a separate secondary phase.
- Connect all X_2 bushings together and bond to the system neutral.

NOTE:
When making Wye secondary connections remember that the phase voltage will always be 1.73 times the phase to neutral voltage.
Example:
Three transformers rated at 120/240 volts on the secondary are connected in Wye.
The phase to neutral voltage is 120.
The phase to phase voltage is $120 \times 1.73 = 208$

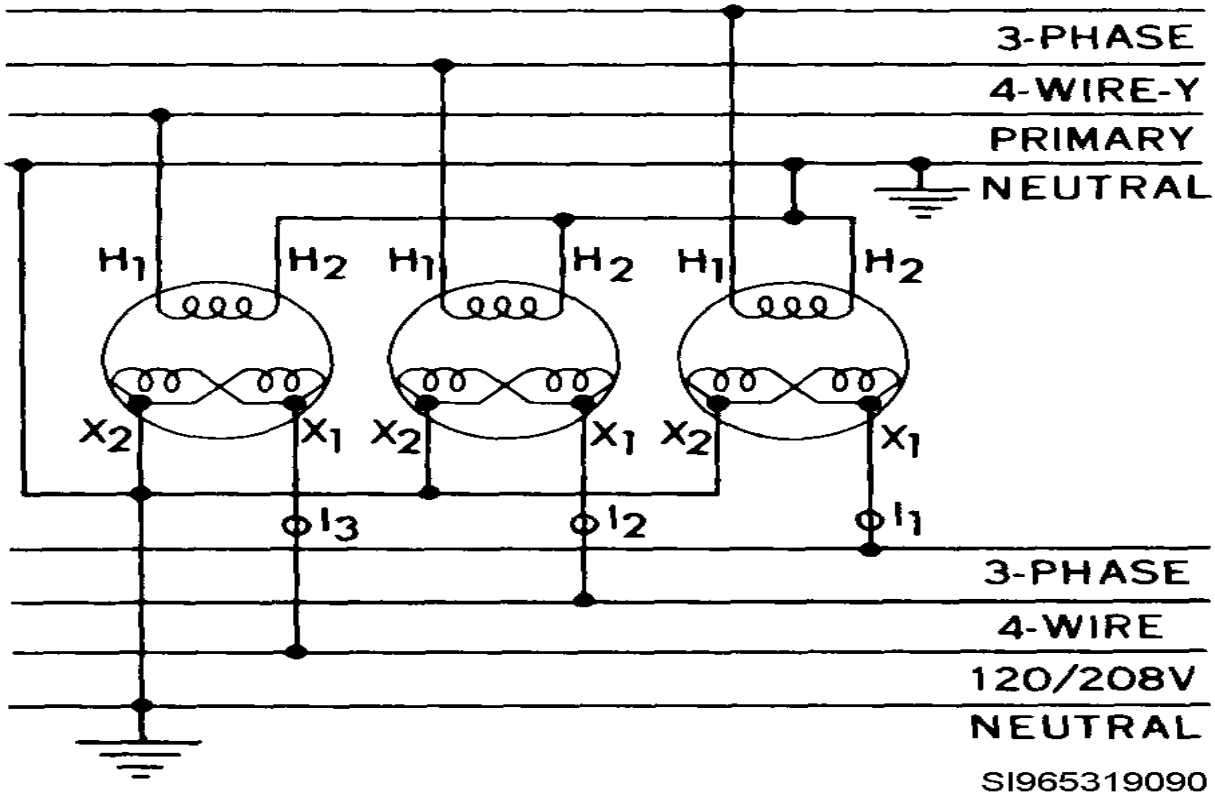


Figure 7, Wye/Wye For Lighting And Power

Step 12: Primary Connection for wye / wye as seen in Figure 7 above.

- Connect each transformer's H_1 bushing to a separate phase through a protective device.
- Connect all the H_2 bushings together and connect to the system neutral.
- Bond the primary and secondary neutrals together.

NOTE:
A Wye primary connection can only be made on a Wye distribution system.

Step 13: Secondary Connection for wye / wye as seen in Figure 7 above.

- Connect each X_1 bushing to a separate secondary phase.
- Connect all the X_2 bushings and bond to the system neutral.

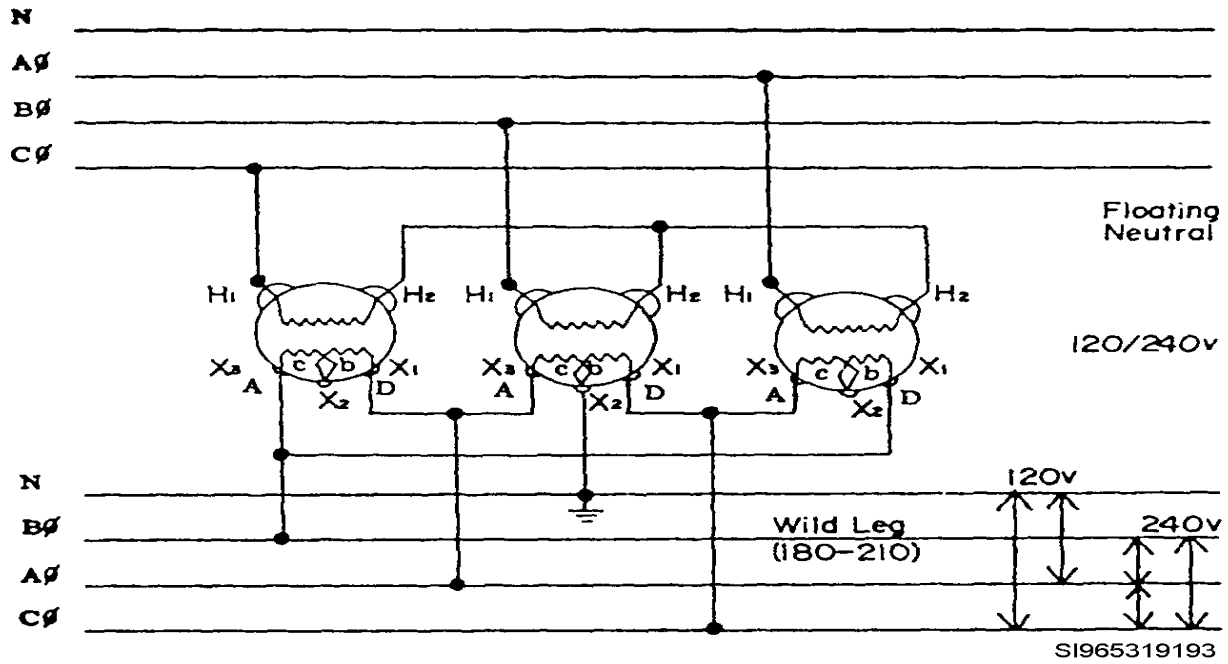


Figure 8, Wye/Delta Connection

Step 14: Primary Connection for wye / delta as seen in Figure 8 above.

- Connect each transformer's H_1 bushing to a separate phase through a protective device.
- Connect all the H_2 bushings together, but in this connection the H_2 is not connected to system neutral, it is floated.

NOTE:
This is done so the transformers fuse cutouts will have sympathetic blowing (two fuses blow) and not just one blow. This prevents the transformers from operating as an open-Delta emergency connection.

Step 15: Secondary Connection for wye / delta as seen in Figure 8 above.

- Connect each transformer X_1 bushing (secondary) to a different secondary phase.
- Connect each X_3 (secondary) bushing to the next closest X_1.
- The last transformer's X_3 will go to the first transformer's X_1.
- It should be arranged so each transformer has two different secondary phases and each phase is used only twice.
- Ground the center X_2 bushing of the center transformer.

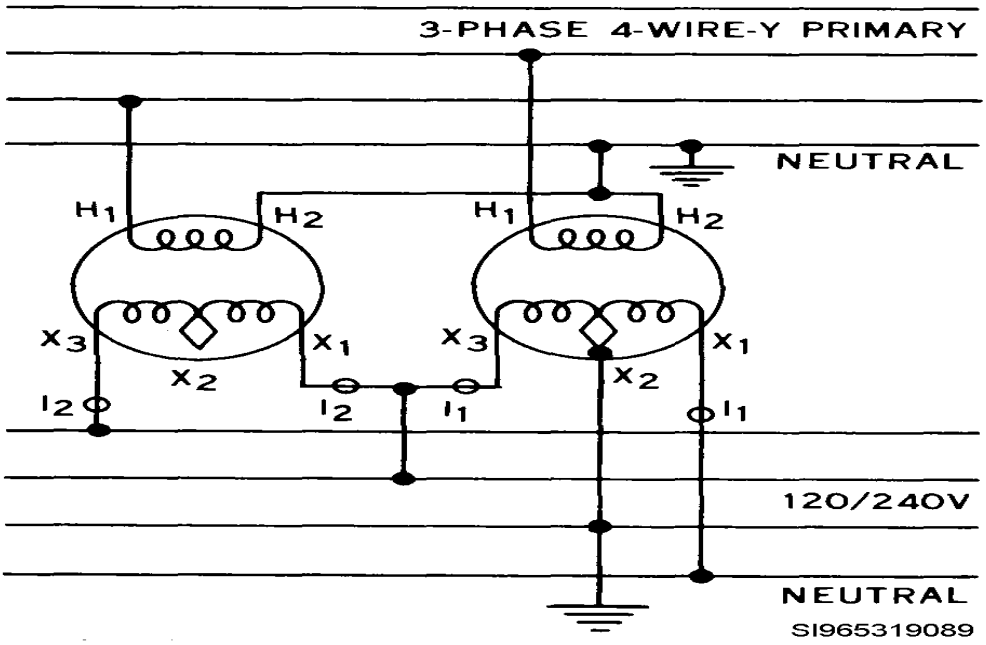


Figure 9, Wye/Open Delta for Lights and Power

Step 16: Primary Connection for wye / open delta as seen in Figure 9 above.

- Connect each transformer's H_1 bushing to a separate phase through a protective device.
- Connect all the H_2 bushings together and connect to the system neutral.
- Bond the primary and secondary neutrals together.

NOTE:
The neutral on the primary side is bonded to the system neutral; whereas, the primary of the Wye/Delta bank is floated.

Step17: Secondary Connection for wye / open delta as seen in Figure 9 above.

- Connect each transformer X_1 bushing (secondary) to a different secondary phase.
- Connect each X_3 (secondary) bushing to the next closest X_1.
- The last transformer's X_3 will go to the first transformer's X_1.
- It should be arranged so each transformer has two different secondary phases and each phase is used only twice.
- Ground the center (X_2) bushing of the larger transformer if applicable. If transformers are the same size, you can ground either transformer.

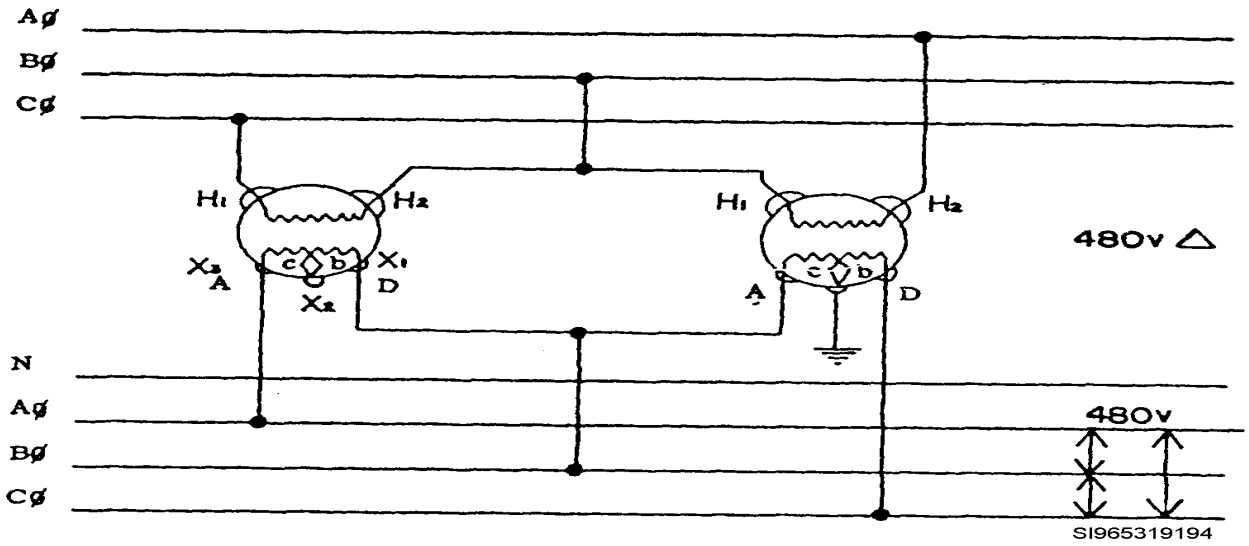


Figure 10, Delta/Open Delta for Lights and Power

Step 18: Primary Connection for delta / open delta as seen in Figure 10 above.

- Connect each transformer's H_1 bushing is to a separate phase through a protective device.
- Connect each H_2 bushing to the next closest H_1, the last transformer's H_2 will go to the first transformers H_1.
- It should be arranged so each transformer has two different phases and each phase is used only twice.

Step19: Secondary Connection for delta / open delta as seen in Figure 10 above.

- Connect each transformer X_1 bushing (secondary) to a different secondary phase.
- Connect each X_3 (secondary) bushing to the next closest X_1.
- The last transformer's X_3 will go to the first transformer's X_1.
- It should be arranged so each transformer has two different secondary phases and each phase is used only twice.
- Ground the center (X_2) bushing of the larger transformer if applicable. If transformers are the same size, you can ground either transformer.

NOTE:
This connection is called a center tap. Center tapping one transformer provides the rating of the secondary windings. This creates a condition known as a wild leg. This is an unusable voltage in relation to ground 180-210 volts. This is usually the farthest lead from the center tap; however, you must trace each phase lead through the transformers windings to determine which goes through three windings to be sure the right one is identified. The wild leg is marked with orange tape or paint so it is not used with neutral.

Review Questions
for
Perform Transformer Connections

Question	Answer
1. What is the secondary voltage of a wye connected transformer bank if the transformers are rated at 120/240VAC?	a. 120/208 VAC b. 120/240 VAC c. 208/240 VAC d. None of the above
2. How must the secondary windings inside the transformer be connected for a single-phase 120/240-volt service?	a. Series b. Parallel c. Series/Parallel d. Any of the above
3. How are the secondary windings inside the transformers identified?	a. They are marked with ID tags or stamped with the letters A,B,C,&D b. They are marked with ID tags or stamped with the letters X_1, X_2, & X_3 c. They are marked with ID tags or stamped with the letters H_1, H_2, & H_3 d. Any of the above
4. What is the sequence of connection for secondary leads in a wye secondary?	a. AC-BD b. A-BC-D c. AB-CD d. CD-BA
5. What is done to the primary neutral of a wye/delta transformer bank?	a. The primary neutrals of all transformers are connected together and “floated”. b. The primary and secondary neutrals are bonded together. c. The secondary neutrals of all loads are connected together and “floated”. d. None of the above
6. What will happen if the neutral of a wye-delta bank is not floated and a primary fuse blows?	a. Nothing b. The bank will operate in open delta c. You will lose one leg of power d. The transformer will burn-up
7. There is no emergency connection for wye secondary connected transformer banks.	a. True b. False

PERFORM TRANSFORMER CONNECTIONS

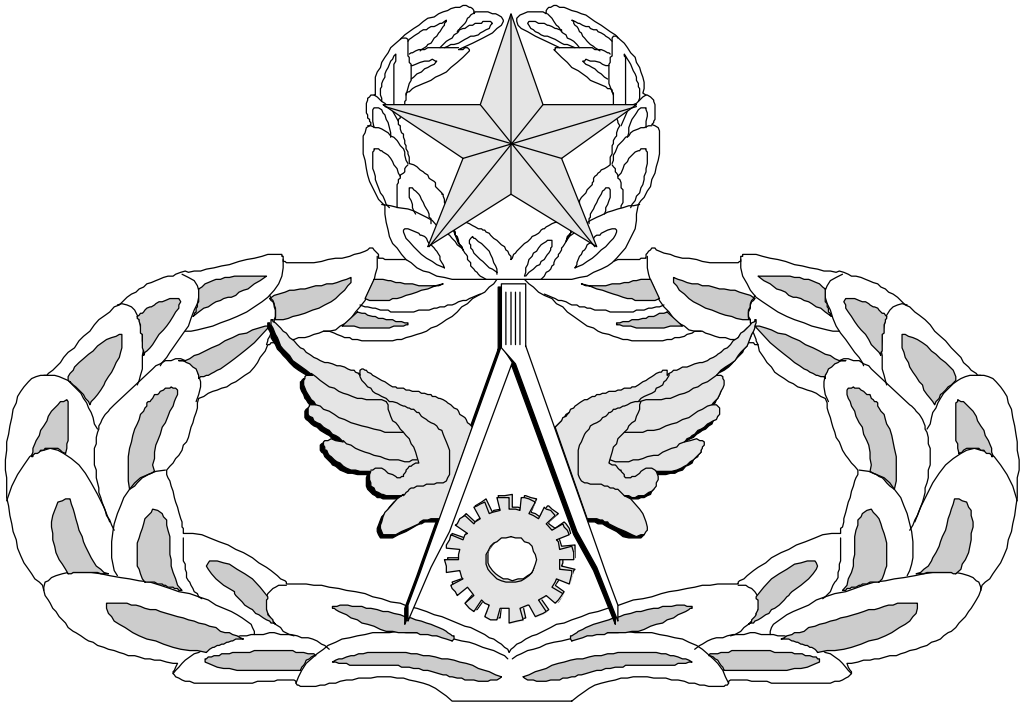
Performance Checklist		
Step	**Yes**	**No**
1. Did the trainee determine the voltage and amperage requirements before beginning work?		
2. Did the trainee determine the proper connections to get the required output from the transformer?		
3. Did the trainee make the correct internal connections to get the desired voltage?		
4. Did the trainee make the correct external connections to get the required voltage?		
5. Can the trainee identify the wild or stinger leg on three-phase transformer banks?		

FEEDBACK: Trainer should provide both positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the mind of both the trainee and trainer.

Air Force Civil Engineer

QUALIFICATION TRAINING PACKAGE (QTP)

REVIEW ANSWER KEY



For

ELECTRICAL SYSTEMS

(3E0X1)

MODULE 16

OVERHEAD DISTRIBUTION SYSTEMS

Notice. This AFQTP is *NOT* intended to replace the applicable technical references nor is it intended to replace hands-on training. It is to be used in conjunction with these for training purposes only.

USING GAFFS

(3E0X1-16.1.1.)

Question	Answer
1. If a pole is leaning, which side should be climbed?	a. Climb the back or high side when possible.
2. When descending the pole, how should you look where you are going?	b. Down your body, between your legs..
3. While circling, the lower kept is keep locked to ensure if you slip, your body weight will drive the gaff on the locked leg back into the pole.	a. True
4. Aim gaffs at the heart (center) of the pole, keeping the toes pointed upward at a ____ degree angle.	b. 30
5. When ascending the pole, you should climb with short steps, approximately ___ to ___ inches.	c. 8, 10
6. The last step to the ground should be how far from the ground?	a. 6 inches
7. What should you inspect your climbers and body belt for?	d. All of the above.

WORKING ON POLE COMPONENTS

(3E0X1-16.1.2.)

Question	Answer
1. In what direction should the keepers face when belting-in?	b. Both outward
2. How can the climber tell if the keeper has snapped into the D-ring?	d. All of the above
3. What is the reason for circling?	a. Obtaining best position for work
4. If you are circling to the left, which leg is low and locked?	a. Left leg
5. How much distance should be gained around the pole with each swing?	b. 3 to 4 inches horizontally
6. What is the purpose of hitch-hiking?	c. To move up and down on the pole.
7. Body weight is used to drive the gaff into the pole when hitch-hiking.	a. True
8. At what level should the crossarm be at when you are in a working position.	c. Chest level.
9. It is important to keep your low leg locked in work positions, because all your weight is on that one leg.	a. True

TRAVERSING OBSTACLES

(3E0X1-16.1.3.)

Question	Answer
1. Prior to transversing obstacles, what must you do?	d. All of the above
2. Conductor can be used as a climbing support.	b. False
3. When transversing a single crossarm what side of the pole do you climb?	b. Opposite of crossarm side
4. When traversing a double crossarm you must climb high enough to_____.	d. Grab the pole above the crossarm.
5. When traversing a clevis, climb the pole until the clevis is _____ level with the lineman.	a. Eye
6. When descending an obstruction, how should you look where you are going?	d. Do whatever feels most comfortable for you.

SET UTILITY POLES

(3E0X1-16.3.4.)

Question	Answer
1. A pole 50 feet in length should be set ____ feet in the ground in normal soil.	d. 7
2. The diameter of a hole for a pole 15 inches in diameter, being tamped with a 2-inch wide tamper should be at least _____ inches in diameter.	c. 19
3. In what position should an auger be placed during the digging process?	c. Vertical
4. The balance point of the pole is located higher than the halfway point of the pole.	b. False
5. What is used to rotate the pole left and right to allow for proper alignment?	a. Cant hook
6. Replacing a pole using the Gin pole method does not require the rigging of the existing pole to raise the new pole.	b. False
7. What must be done to the center conductor of a pole, when the gin pole method is applied?	b. The conductor must be tied to the crossarm
8. In the piking method, what is placed between the pole and the ground to prevent it from falling during lifting?	c. Jinny
9. In the piking method, who provides control and stabilization during the lifting process?	c. Guide pikers

OVERHEAD LINE CONDUCTORS

(3E0X1-16.4.2.)

Question	Answer
1. Any overhead work should begin with a _____ session in which the job is explained to each worker.	c. Tailgate
2. What determines the pulling equipment used during an overhead conductor installation?	c. The size of conductor
3. Pilot lines or normally only used on large conductors or long conductor runs.	a. True
4. Whenever the potential for contact between overhead conductors and energized equipment exists, what must be accomplished?	d. Cover equipment with rubber blankets.
5. When installing conductors on or around poles with energized lines, always ground the equipment you are using to the conductors being installed and bond them _____.	c. To the system neutral
6. The line truck is grounded by connecting a ground clamp to a separate ground and the other end to the truck itself.	b. true
7. The first step before phasing in an overhead line is _____.	b. Testing the phasing tool

CONDUCTOR SUPPORT DEVICES

(3E0X1-16.4.4.1.)

Question	Answer
1. Conductor support devices are used to support the conductor off the ground.	a. True
2. Installation procedures are the same on every job.	b. False
3. Before raising the crossarm up the pole, the pins, insulators, braces and bolts should be installed by the _____.	c. Groundman
4. The crossarm braces have two different sized holes on the ends.	a. True
5. The lineman should be just below the throughbolt hole, _____ inches from the top of the pole.	a. 12
6. The vertical epoxy arms are installed to the sides of the pole with the first hole _____ inches from the top.	b. 9
7. There are several different types of insulators and the way they are installed depends on the type of insulator.	a. True
8. The suspension insulator is installed where the conductor terminates.	a. True
9. The spool insulator is installed in a _____ which is bolted to the pole.	b. Clevis
10. Always ensure that tools and equipment are securely fastened to the handline before raising or lowering.	a. True

TRANSFORMERS

(3E0X1-16.4.4.2.)

Question	Answer
1. Movement of transformers should be done with care to prevent damage.	a. True
2. When raising a transformer manually, you can lift using the bushings.	b. False
3. Cluster bracket transformer installation requires the same equipment as directly pole mounted.	a. True
4. Due to some obstructions the line truck may need to be repositioned in order to reach all transformer locations.	a. True
5. Never position yourself under any suspended loads.	a. True

PROTECTIVE DEVICES

(3E0X1-16.4.4.3.)

Question	Answer
1. Transformers must be protected from _____.	d. Both B and C
2. Lightning Arresters provide _____ protection.	b. Overvoltage
3. Fused Cutouts provide _____ protection.	a. Overcurrent
4. The lightning arrestor is installed on the crossarm only.	b. False
5. An accessory arm is a crossarm installed below the primary circuit.	a. True
6. The handline is installed _____ the work position to allow easy access to equipment that is sent up the handline.	a. Above
7. Once installed on the accessory arm, the protective devices can be connected to the overhead lines and equipment.	b. False
8. The groundman should not stand underneath any suspended objects.	a. True

SERVICE DROPS

(3E0X1-16.4.7.)

Question	Answer
1. What is the minimum clearance above the ground that the service drop may be attached to a building?	a. 10 feet
2. How far must a service drop clear an alley?	d. 18 feet
3. When a service drop is attached to the side of a building, how far must it be away from the side of a window?	a. 3 feet
4. The maximum distance for a service drop with a wire size No. 2 is 100 feet.	a. True
5. Triplex has ____ insulated conductor(s) wrapped around ___ bare conductor(s).	d. 2, 1
6. A service drop using 1/0 or larger wire should not exceed a maximum distance of ____ feet?	b. 75
7. What is done at the service entrance to prevent water from entering the weatherhead?	c. Form a drip loop with the conductors
8. What is used to sag the service drop?	c. Only done by hand
9. What is the minimum distance above a window that the service drop must be attached?	d. There is no minimum distance required

GROUNDING SET

(3E0X1-16.4.9.)

Question	Answer
1. What must be accomplished before you work on de-energized lines?	c. Test for voltage and ground
2. Installation of ground set protects workers from _____.	d. All of the above
3. The first step in performing a circuit safety check is _____.	b. Open the circuit
4. Hot line clamps and grounding clamps are interchangeable.	b. False
5. Cables used in grounding must be _____.	d. All of the above
6. The use of line terminals provided with ground switches waives the use of grounding sets.	b. False

INSPECT POLES AND INSTALLED EQUIPMENT

(3E0X1-16.5.)

Question	Answer
1. Distribution lines should be inspected at scheduled intervals not to exceed ____ years.	d. 5
2. Hardware on wooden poles are inspected for _____.	d. All of the above.
3. Wooden crossarms are inspected for ___.	a. Decay around pin holes
4. Insulators should have a _____ surface to prevent flashover.	b. Glass like glaze
5. What do you inspect a transformer case for?	c. Leaking oil
6. During load tests portable ammeter should be installed for at least _____ hours on the day during peak loading period.	c. 24
7. Contact clips and ferrules can be covered with a special non-corrosive conductive lubricant.	a. True
8. When performing a visual inspection of lightning arrestors, what are you looking for?	c. Tight connections
9. If the line can be de-energized how can you clean contacts of an air break switch?	c. Opening and Closing switch
10. Replacement of bad gaskets found during inspection of oil filled equipment is not required	b. False

PERFORM TRANSFORMER CONNECTIONS

(3E0X1-16.15.)

Question	Answer
1. What is the secondary voltage of a wye connected transformer bank if the transformers are rated at 120/240VAC?	a. 120/208 VAC
2. How must the secondary windings inside the transformer be connected for a single-phase 120/240-volt service?	a. Series
3. How are the secondary windings inside the transformers identified?	a. They are marked with ID tags or stamped with the letters A,B,C,&D
4. What is the sequence of connection for secondary leads in a wye secondary?	a. AC-BD
5. What is done to the primary neutral of a wye/delta transformer bank?	a. The primary neutrals of all transformers are connected together and “floated”.
6. What will happen if the neutral of a wye-delta bank is not floated and a primary fuse blows?	b. The bank will operate in open delta
8. There is no emergency connection for wye secondary connected transformer banks.	a. True